

Contents

Chapter 1: Ray Optics

- DPP 1.1 Reflection 1.1
- DPP 1.2 Refraction 1.4
- DPP 1.3 Refraction Curve 1.6
- DPP 1.4 Lens 1.8
- DPP 1.5 Prism 1.10
- DPP 1.6 Optical Instruments 1.12

1.1–1.12

Chapter 2: Wave Optics

- DPP 2.1 Wave Nature and Basic Theory of Interference of Light 2.1
- DPP 2.2 Young's Double Slit Experiment (Basic) 2.4
- DPP 2.3 Introduction of Mica Sheet in Young's Double Slit Experiment 2.6
- DPP 2.4 Different Cases in Young's Double Slit Experiment 2.8

2.1–2.10

Chapter 3: Electrons, Photons, Photoelectric Effect and X-Rays

- DPP 3.1 Radiation Pressure and Matter Waves 3.1
- DPP 3.2 Photoelectric effect 1 3.3
- DPP 3.3 Photoelectric Effect 2 3.5

3.1–3.6

Chapter 4: Atomic Physics

- DPP 4.1 Bohr Model of Atomic Structure 1 4.1
- DPP 4.2 Bohr Model of Atomic Structure 2 4.3
- DPP 4.3 X-Rays 4.5

4.1–4.6

Chapter 5: Nuclear Physics

- DPP 5.1 Atomic Nucleus and Mass Defect 5.1
- DPP 5.2 Binding Energy 5.3
- DPP 5.3 α , β and γ Decay and Radioactivity 5.4
- DPP 5.4 Radioactivity 5.5
- DPP 5.5 Nuclear Fission and Fusion 5.6

5.1–5.8

Solutions

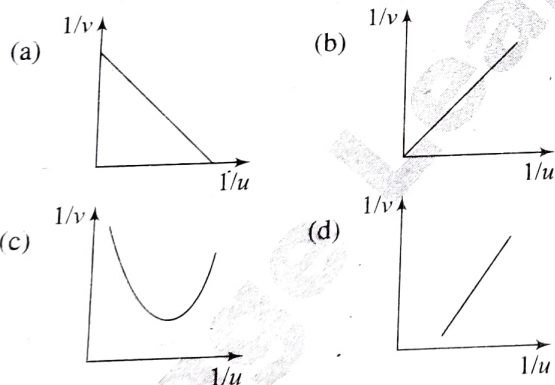
S.1–S.

DPP 1.1

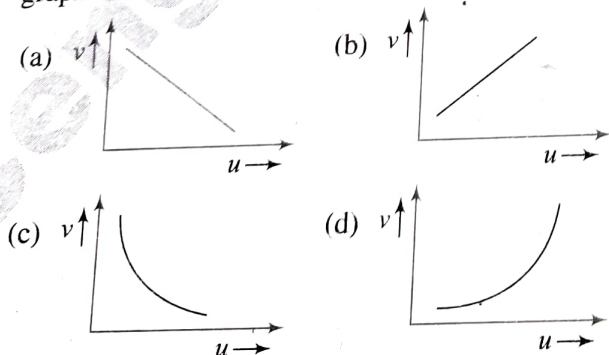
Reflection

Single Correct Answer Type

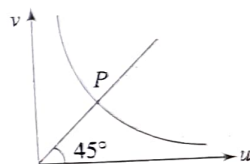
1. For a concave mirror, if real image is formed the graph between $\frac{1}{u}$ and $\frac{1}{v}$ is of the form



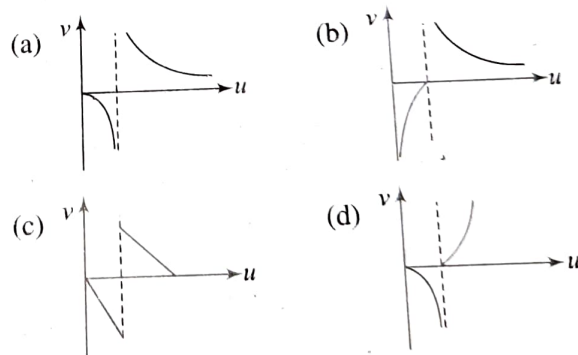
2. In an experiment, the focal length of a concave mirror on a graph is drawn between the magnitudes of u and v . The graph looks like



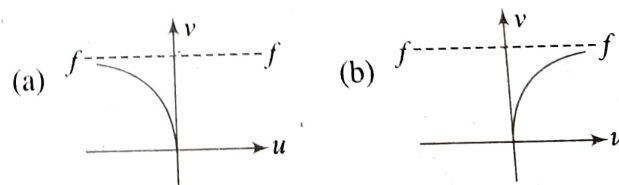
3. The graph shows variation of v with change in u for a mirror. Points plotted above the point P on the curve are for values of v



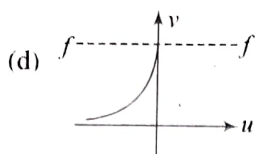
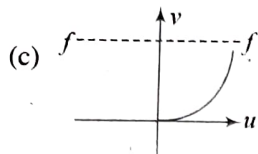
- (a) Smaller than f
(b) Smaller than $2f$
(c) Larger than $2f$
(d) Larger than f
4. As the position of an object (u) reflected from a concave mirror is varied, the position of the image (v) also varies. By letting the u change from 0 to $+\infty$ the graph between v versus u will be



5. The graph between u and v for a convex mirror is



1.2 Optics and Modern Physics



6. A convergent beam of light is incident on a convex mirror so as to converge to a distance 12 cm from the pole of the mirror. An inverted image of the same size is formed coincident with the virtual object. What is the focal length of the mirror?

(a) 24 cm (b) 12 cm (c) 6 cm (d) 3 cm

7. A thin rod of 5 cm length is kept along the axis of a concave mirror of 10 cm focal length such that its image is real and magnified and one end touches the rod. Its magnification will be

(a) 1 (b) 2 (c) 3 (d) 4

8. A square of side 3 cm is placed at a distance of 25 cm from a concave mirror of focal length 10 cm. The centre of the square is at the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the square is

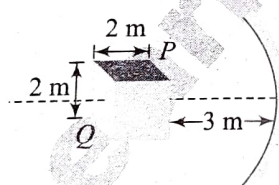
(a) 4 cm² (b) 6 cm² (c) 16 cm² (d) 36 cm²

9. A small piece of wire bent into an L shape with upright and horizontal portions of equal lengths is placed with the horizontal portion along the axis of the concave mirror whose radius of curvature is 10 cm. If the bend is 20 cm from the pole of the mirror, then the ratio of the lengths of the images of the upright and horizontal portions of the wire is

(a) 1 : 2 (b) 3 : 1 (c) 1 : 3 (d) 2 : 1

10. A cube of side 2 m is placed in front of a concave mirror focal length 1 m with its face P at a distance of 3 m and face Q at a distance of 5 m from the mirror. The distance between the images of face P and Q and height of images of P and Q are

(a) 1 m, 0.5 m, 0.25 m (b) 0.5 m, 1 m, 0.25 m
(c) 0.5 m, 0.25 m, 1 m (d) 0.25 m, 1 m, 0.5 m



11. AB is an incident beam of light and CD is a reflected beam (the number of reflections for this may be 1 or more than 1) of light. AB and CD are separated by some distance (may be large). It is possible by placing what type of mirror on the right side.

(a) one plane mirror (b) one concave mirror
(c) one convex mirror (d) none of these

12. A point object is moving along principal axis of a concave mirror with uniform velocity towards pole. Initially the object is at infinite distance from pole on right side of the mirror as shown. Before the object collides with mirror, the number of times at which the distance between object and its image is 40 cm is:



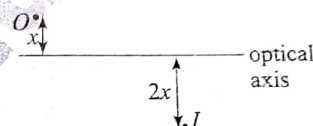
(a) one time (b) two times
(c) three times (d) data insufficient

Multiple Correct Answers Type

13. A particle is moving towards a fixed convex mirror. The image also moves. If V_i = speed of image and V_o = speed of the object, then

(a) $V_i \leq V_o$ if $|u| < |f|$ (b) $V_i > V_o$ if $|u| > |f|$
(c) $V_i < V_o$ if $|u| > |f|$ (d) $V_i = V_o$ if $|u| = |f|$

14. The positions of the object O (real or virtual) and the image I (real or virtual) with respect to the optical axis of a spherical mirror is shown. Then select the possible mirror and its position to realise it.



(a) concave mirror closer to object
(b) concave mirror closer to image
(c) convex mirror closer to object
(d) convex mirror closer to image

Matching Column Type

15. Match the options of the following columns.

	Column I		Column II
(A)	For real extended object, if image formed by a single mirror is erect, and if the size of image is smaller than object, the mirror is	(P)	Concave
(B)	For real extended object, if the size image is smaller than object, the mirror is	(Q)	Convex
(C)	For real extended object, if image formed by a single mirror is erect and if the size of image is larger than object, then mirror is	(R)	(f, f)
(D)	For spherical mirrors, a line $u = v$ will cut the curve between u and v at a point.	(S)	(2f, 2f)

Answers Key**Single Correct Answer Type**

- | | | | | |
|---------|---------|--------|--------|---------|
| 1. (a) | 2. (c) | 3. (c) | 4. (a) | 5. (a) |
| 6. (c) | 7. (b) | 8. (a) | 9. (b) | 10. (d) |
| 11. (b) | 12. (c) | | | |

Multiple Correct Answers Type

13. (a, c) 14. (a, c)

Matching Column Type

15. (A) $\rightarrow$ Q; (B) $\rightarrow$ P; (C) $\rightarrow$ P; (D) $\rightarrow$ S

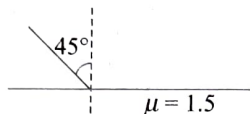
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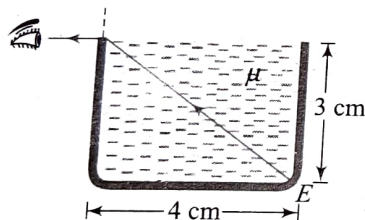
Refraction

Single Correct Answer Type

1. One side of a glass slab is silvered as shown. A ray of light is incident on the other side at angle of incidence $i = 45^\circ$. Refractive index of glass is given as 1.5. The deviation of the ray of light from its initial path when it comes out of the slab is

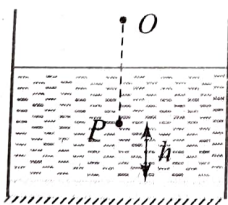


- (a) 90° (b) 180° (c) 120° (d) 45°
2. When the rectangular metal tank is filled to the top with an unknown liquid, as observer with eyes level with the top of the tank can just see the corner E; a ray that refracts towards the observer at the top surface of the liquid is shown. The refractive index of the liquid will be



- (a) 1.2 (b) 1.4 (c) 1.6 (d) 1.9
3. A transparent cube of 15 cm edge contains a small air bubble. Its apparent depth when viewed through one face is 6 cm and when viewed through the opposite face is 4 cm. Then the refractive index of the material of the cube is

- (a) 2.0 (b) 2.5 (c) 1.6 (d) 1.5
4. A plane mirror is placed at the bottom of the tank containing a liquid of refractive index μ . P is a small object at a height h above the mirror. An observer O , vertically above P outside the liquid, sees P and its image in the mirror. The apparent distance between these two will be



- (a) $2\mu h$ (b) $\frac{2h}{\mu}$ (c) $\frac{2h}{\mu - 1}$ (d) $h\left(1 + \frac{1}{\mu}\right)$
5. One face of a rectangular glass plate 6 cm thick is silvered. An object held 8 cm in front of the first face forms an image

12 cm behind the silvered face. The refractive index of the glass is

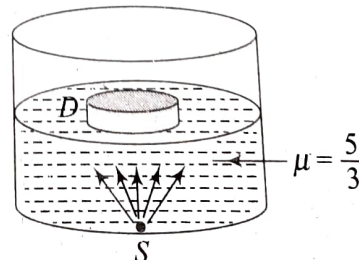
- (a) 0.4 (b) 0.8 (c) 1.2 (d) 1.6
6. A concave mirror is placed at the bottom of an empty tank with face upwards and axis vertical. When sunlight falls normally on the mirror, it is focussed at distance of 32 cm from the mirror. If the tank is filled with water $\left(\mu = \frac{4}{3}\right)$ up to

a height of 20 cm, then the sunlight will now get focussed at

- (a) 16 cm above water level
(b) 9 cm above water level
(c) 24 cm below water level
(d) 9 cm below water level
7. A slab of glass, of thickness 6 cm and refractive index 1.5, is placed in front of a concave mirror, the faces of the slab being perpendicular to the principal axis of the mirror. If the radius of curvature of the mirror is 40 cm and the reflected image coincides with the object, then the distance of the object from the mirror is
- (a) 30 cm (b) 22 cm (c) 42 cm (d) 28 cm
8. A ray of light travels from an optically denser to rarer medium. The critical angle for the two media is C . The maximum possible deviation of the ray will be

- (a) $\left(\frac{\pi}{2} - C\right)$ (b) $2C$
(c) $\pi - 2C$ (d) $\pi - C$

9. A point source of light S is placed at the bottom of a vessel containing a liquid of refractive index $5/3$. A person is viewing the source from above the surface. There is an opaque disc D of radius 1 cm floating on the surface of the liquid. The centre of the disc lies vertically above the source S . The liquid from the vessel is gradually drained out through a tap. The maximum height of the liquid for which the source cannot be seen at all from the above is



- (a) 1.50 cm (b) 1.64 cm (c) 1.33 cm (d) 1.86 cm

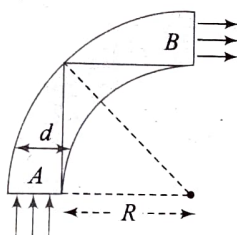
10. Light enters at an angle of incidence in a transparent rod of refractive index n . For what value of the refractive index of the material of the rod the light once entered into it will not leave it through its lateral face whatsoever be the value of angle of incidence

- (a) $n > \sqrt{2}$ (b) $n = 1$
(c) $n = 1.1$ (d) $n = 1.3$

11. An optical fibre consists of core of μ_1 surrounded by a cladding of $\mu_2 < \mu_1$. A beam of light enters from air at an angle α with axis of fibre. The highest α for which ray can be travelled through fibre is

- (a) $\cos^{-1} \sqrt{\mu_2^2 - \mu_1^2}$ (b) $\sin^{-1} \sqrt{\mu_1^2 - \mu_2^2}$
(c) $\tan^{-1} \sqrt{\mu_1^2 - \mu_2^2}$ (d) $\sec^{-1} \sqrt{\mu_1^2 - \mu_2^2}$

12. A rod of glass ($\mu = 1.5$) and of square cross section is bent into the shape shown in the figure. A parallel beam of light falls on the plane flat surface A as shown in the figure. If d is the width of a side and R is the radius of circular arc then for what maximum value

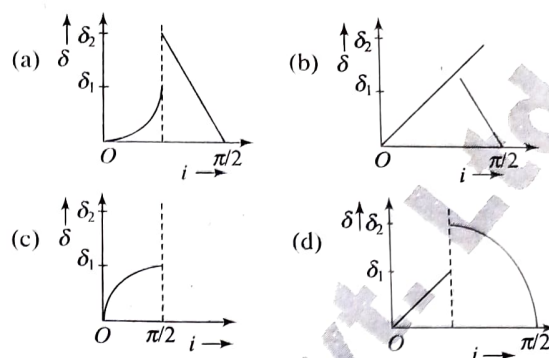


of $\frac{d}{R}$ light entering the glass slab through surface A

emerges from the glass through B

- (a) 1.5 (b) 0.5
(c) 1.3 (d) None of these

13. A ray of light travels from a medium of refractive index μ to air. Its angle of incidence in the medium is i , measured from the normal to the boundary, and its angle of deviation is δ . δ is plotted against i which of the following best represents the resulting curve

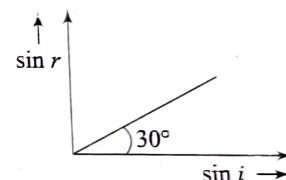


14. The apparent depth of water in cylindrical water tank of diameter $2R$ cm is reducing at the rate of x cm/minute when water is being drained out at a constant rate. The amount of water drained in c.c. per minute is (n_1 = refractive index of air, n_2 = refractive index of water)

- (a) $x \pi R^2 n_1/n_2$ (b) $x \pi R^2 n_2/n_1$
(c) $2\pi R n_1/n_2$ (d) $\pi R^2 x$

Multiple Correct Answers Type

15. When light is incident on a medium at angle i and refracted into a second medium at an angle r , the graph of $\sin i$ vs. $\sin r$ is as shown in the graph. From this, one can conclude that



- (a) velocity of light in the second medium is 1.73 times the velocity of light in the I medium
(b) velocity of light in the I medium is 1.73 times the velocity in the II medium
(c) the critical angle for the two media is given by $\sin$

$$i_c = \frac{1}{\sqrt{3}}$$

- (d) $\sin i_c = \frac{1}{2}$

Answers Key

Single Correct Answer Type

1. (a) 2. (a) 3. (d) 4. (b) 5. (c)
6. (b) 7. (c) 8. (c) 9. (c) 10. (a)
11. (b) 12. (b) 13. (a) 14. (b)

Multiple Correct Answers Type

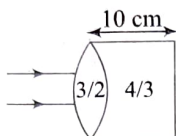
15. (b, c)

DPP 1.3

Refraction Curve

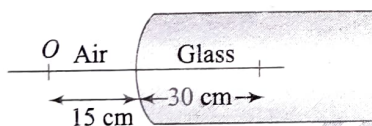
Subjective Type

1. A parallel paraxial beam of light is incident on the arrangement as shown ($\mu_A = 3/2$, $\mu_B = 4/3$). The two spherical surfaces are very close and each has a radius of curvature 10 cm. Find the point where the rays are focussed. (w.r.t. point of entry)



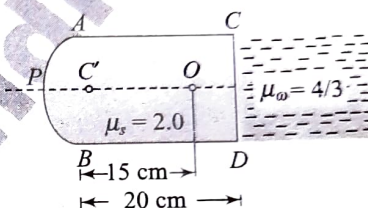
Single Correct Answer Type

2. A ray of light falls on the surface of a spherical glass paper weight making an angle α with the normal and is refracted in the medium at an angle β . The angle of deviation of the emergent ray from the direction of the incident ray
- (a) $(\alpha - \beta)$ (b) $2(\alpha - \beta)$
(c) $(\alpha - \beta)/2$ (d) $(\beta - \alpha)$
3. A point object O is placed in front of a glass rod having spherical end of radius of curvature 30 cm. The image would be formed at

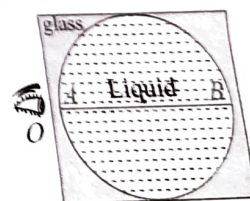
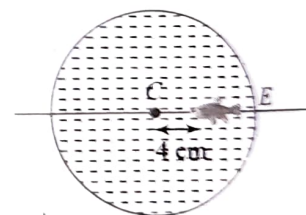


- (a) 30 cm left (b) Infinity
(c) 1 cm to the right (d) 18 cm to the left
4. A glass hemisphere of radius 0.04 m and R.I. of the material 1.6 is placed centrally over a cross mark on a paper (i) with the flat face; (ii) with the curved face in contact with the paper. In each case the cross mark is viewed directly from above. The position of the images will be
- (a) (i) 0.04 m from the flat face; (ii) 0.025 m from the flat face
(b) (i) At the same position of the cross mark; (ii) 0.025 m below the flat face
(c) (i) 0.025 m from the flat face; (ii) 0.04 m from the flat face
(d) For both (i) and (ii) 0.025 m from the highest point of the hemisphere
5. An air bubble in sphere having 4 cm diameter appears 1 cm from surface nearest to eye when looked along diameter. If $\mu_g = 1.5$, the distance of bubble from refracting surface is
- (a) 1.2 cm (b) 3.2 cm (c) 2.8 cm (d) 1.6 cm

6. The slab of a material of refractive index 2 shown in the figure has curved surface APB of radius of curvature 10 cm and a plane surface CD . On the left of APB is air and on the right of CD is water with refractive indices as given in the figure. An object O is placed at a distance of 15 cm from pole P as shown. The distance of the final image of O from P , as viewed from the left is

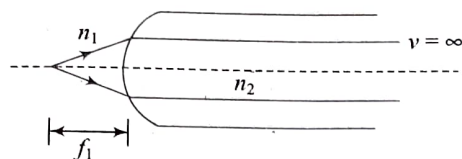


- (a) 20 cm (b) 30 cm (c) 40 cm (d) 50 cm
7. A parallel beam of light emerges from the opposite surface of the sphere when a point source of light lies at the surface of the sphere. The refractive index of the sphere is
- (a) $\frac{3}{2}$ (b) $\frac{5}{3}$ (c) 2 (d) $\frac{5}{2}$
8. In a thin spherical fish bowl of radius 10 cm filled with water of refractive index $4/3$ there is a small fish at a distance of 4 cm from the centre C as shown in the figure. Where will the image of fish appears, if seen from E .
- (a) 5.2 cm (b) 7.2 cm (c) 4.2 cm (d) 3.2 cm
9. The observer 'O' sees the distance AB as infinitely large. If refractive index of liquid is μ_1 and that of glass is μ_2 , then $\frac{\mu_1}{\mu_2}$ is:
- (a) 2 (b) $\frac{1}{2}$ (c) 4 (d) None of these



Multiple Correct Answers Type

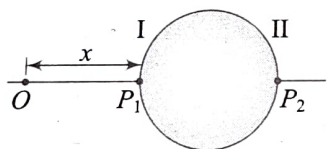
10. The first focal length f_1 for refraction at a spherical surface is defined as the value of u corresponding to $v = \infty$ (as shown) with refractive indices of two mediums, as n_1 and n_2 . The second focal length f_2 is defined as value of v for $u = \infty$.



- (a) f_2 is equal to $\frac{n_2 R}{(n_2 - n_1)}$
 (b) f_1 is equal to $\frac{n_2 R}{(n_2 - n_1)}$
 (c) f_2 is equal to $(-)\frac{n_1 R}{(n_2 - n_1)}$
 (d) f_1 is equal to $(-)\frac{n_1 R}{(n_2 - n_1)}$

Comprehension Type

Figure shows a point object placed in front of a transparent sphere of radius 20 cm and refractive index 1.5. The sphere forms an image due to refraction at surface I followed by refraction at surface II. The sphere is kept in air and the object is located at distance x from P_1 . It is found that for $x > x_1$, the image formed due to refraction at surface I is real, the final image formed by the sphere is also real and forms to the right of P_2 . For $x_2 < x < x_1$, the image formed by surface I is virtual while the final image formed by the sphere is real and forms to the right of P_2 . However, for $x < x_2$, the image formed by surface I and also the final image formed by the sphere are virtual.



It is also found that the final image is virtual if the distance of image formed by surface I from P_2 is less than y . The object is now moved away from the sphere so that x becomes large and say, $x \rightarrow \infty$. In this case, the final image is formed at distance y_1 from P_2 . If the given sphere is replaced by another one of the same radius but of refractive index 2.5, the final image is formed at distance y_2 from P_2 .

11. Distance x_1 such that for $x > x_1$, the image formed by surface I and also the final image are real, is
(a) 60 cm (b) 40 cm (c) 20 cm (d) 10 cm
12. Distance x_2 such that for $x_2 < x < x_1$, the image formed by surface I is virtual but the final image is real, is
(a) 10 cm (b) 25 cm (c) 40 cm (d) 32.5 cm
13. As stated above, if the distance of image formed by Surface 1 from P_2 is less than y , the final image is virtual. Then, y will be
(a) 40 cm (b) 60 cm (c) 80 cm (d) 100 cm
14. For the object placed at $x \rightarrow \infty$, the given sphere of refractive index 1.5 forms an image at distance y_1 from P_2 .
(a) this image is real and $y_1 = 12.5$ cm right of P_2
(b) this image is real and $y_1 = 10$ cm right of P_2
(c) this image is real and $y_1 = 20$ cm right of P_2
(d) this image is virtual and $y_1 = 12$ cm left of P_2
15. For the object placed at $x \rightarrow \infty$, a sphere of the same radius but of refractive index 2.5 forms an image at distance y_2 from P_2 .
(a) this image is real and $y_2 = 6.67$ cm right of P_2
(b) this image is virtual and $y_2 = 6.67$ cm left of P_2
(c) this image is virtual and $y_2 = 3.33$ cm left of P_2
(d) this image is real and $y_2 = 2.5$ cm left of P_2

Answers Key

Subjective Type

- 1.** 17.5 cm

Single Correct Answer Type

2. (b) 3. (a) 4. (b) 5. (a) 6. (b)
7. (c) 8. (a) 9. (a)

Multiple Correct Answers Type

- 10. (a, d)**

Comprehension Type

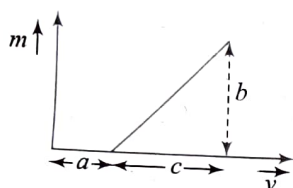
- 11. (b) 12. (a) 13. (b) 14. (b) 15. (c)**

DPP 1.4

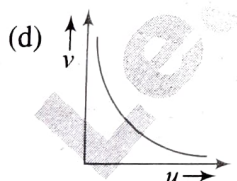
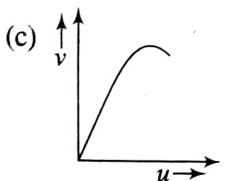
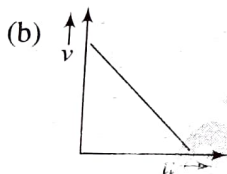
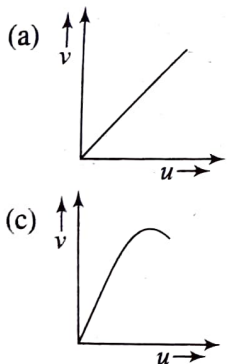
Lens

Single Correct Answer Type

1. The graph shows how the magnification m produced by a convex thin lens varies with image distance v . What was the focal length?



- (a) $\frac{b}{c}$ (b) $\frac{b}{ca}$ (c) $\frac{bc}{a}$ (d) $\frac{c}{b}$
2. The distance v of the real image formed by a convex lens is measured for various object distance u . A graph is plotted between v and u , which one of the following graphs is correct



3. A point object O is placed on the principal axis of a convex lens of focal length 20 cm at a distance of 40 cm to the left of it. The diameter of the lens is 10 cm. If the eye is placed 60 cm to the right of the lens at a distance h below the principal axis, then the maximum value of h to see the image will be

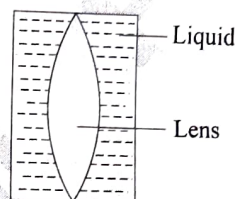
- (a) 0 (b) 5 cm (c) 2.5 cm (d) 10 cm

4. A luminous object is placed at a distance of 30 cm from the convex lens of focal length 20 cm. On the other side of the lens, at what distance from the lens a convex mirror of radius of curvature 10 cm be placed in order to have an upright image of the object coincident with it

- (a) 12 cm (b) 30 cm (c) 50 cm (d) 60 cm

5. Shown in the figure here is a convergent lens placed inside a cell filled with a liquid. The lens has focal length +20 cm when in air and its material has refractive index 1.50. If

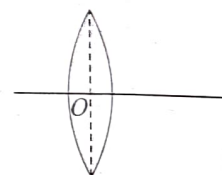
the liquid has refractive index 1.60, the focal length of the system is



- (a) +80 cm (b) -80 cm (c) -24 cm (d) -100 cm
6. Two point light sources are 24 cm apart. Where should a convex lens of focal length 9 cm be put in between them from one source so that the images of both the sources are formed at the same place?

- (a) 6 cm (b) 9 cm (c) 12 cm (d) 15 cm

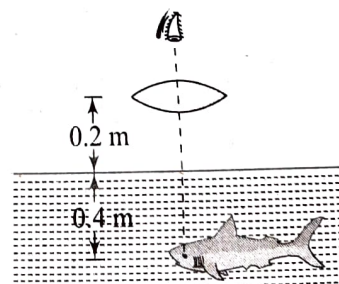
7. The distance between a convex lens and a plane mirror is 10 cm. The parallel rays incident on the convex lens after reflection from the mirror form image at the optical centre of the lens. Focal length of lens will be



- (a) 10 cm (b) 20 cm
(c) 30 cm (d) Cannot be determined

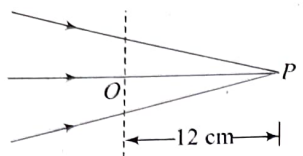
8. A small fish 0.4 m below the surface of a lake is viewed through a simple converging lens of focal length 3 m. The lens is kept at 0.2 m above the water surface such that fish lies on the optical axis of the lens. The image of the fish

seen by observer will be at $\left(\mu_{\text{water}} = \frac{4}{3}\right)$



- (a) A distance of 0.2 m from the water surface
(b) A distance of 0.6 m from the water surface
(c) A distance of 0.3 m from the water surface
(d) The same location of fish

9. The following figure shows a beam of light converging at point P . When a convex lens of focal length 16 cm is introduced in the path of the beam at a place O shown by dotted line such that OP becomes the axis of the lens, the beam converges at a distance x from the lens. The value x will be equal to



- (a) 12 cm (b) 24 cm (c) 36 cm (d) 48 cm

Multiple Correct Answers Type

10. The object distance u , the image distance v and the magnification m in a lens follow certain linear relations. These are

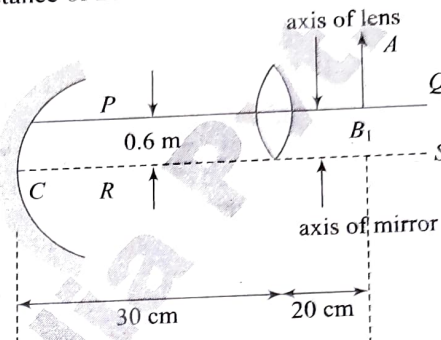
- (a) $\frac{1}{u}$ versus $\frac{1}{v}$ (b) m versus u
(c) u versus v (d) m versus v

11. A biconvex thin lens is prepared from glass of refractive index $\mu_2 = \frac{3}{2}$. The two conducting surfaces have equal radii of 20 cm each. One of the surface is silvered from outside to make it reflecting. It is placed in a medium of refractive index $\mu_1 = \frac{5}{3}$. It acts as a

- (a) converging mirror
(b) diverging mirror
(c) concave mirror of focal length 12.5 cm
(d) convex mirror of focal length 12.5 cm

Comprehension Type

A convex lens of focal length 15 cm and concave mirror of focal length 30 cm are kept with their optical axes PQ and RS parallel but separated in vertical direction by 0.6 m, as shown. The distance between the lens and mirror is 30 cm. An upright object AB of height 1.2 m is placed on the optic axis PQ of the lens at a distance of 20 cm from the lens.



12. Find the linear magnification of the first image after refraction from the lens.
(a) +3 (b) -3 (c) +2 (d) -2
13. Find the linear magnification of the second image after reflection from the mirror.
(a) +2 (b) -2 (c) $+\frac{1}{2}$ (d) $-\frac{1}{2}$
14. If $A'B'$ is the final image formed, A' corresponding to A and B' corresponding to B , find the distance of B' below optics axis of lens.
(a) 0.3 m (b) 0.5 m
(c) 0.6 m (d) None of these
15. As in the last problem, find the distance of A' below the optic axis of lens.
(a) 1.5 cm (b) 0.6 cm (c) 1.8 cm (d) 2.1 cm

Answers Key

Single Correct Answer Type

1. (d) 2. (d) 3. (c) 4. (c) 5. (d)
6. (a) 7. (b) 8. (d) 9. (d)

Multiple Correct Answers Type

10. (a, d) 11. (a, c)

Comprehension Type

12. (b) 13. (c) 14. (a) 15. (d)

DPP 1.5

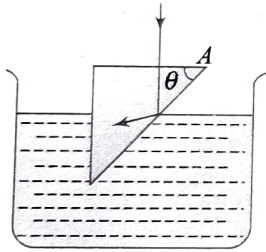
Prism

Single Correct Answer Type

1. A ray of light is incident on the hypotenuse of a right-angled prism after travelling parallel to the base inside the prism. If μ is the refractive index of the material of the prism, the maximum value of the base angle for which light is totally reflected from the hypotenuse is

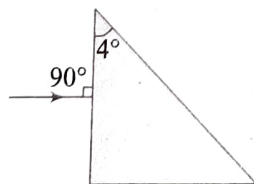
(a) $\sin^{-1}\left(\frac{1}{\mu}\right)$ (b) $\tan^{-1}\left(\frac{1}{\mu}\right)$
 (c) $\sin^{-1}\left(\frac{\mu-1}{\mu}\right)$ (d) $\cos^{-1}\left(\frac{1}{\mu}\right)$

2. The refractive index of the material of the prism and liquid are 1.56 and 1.32 respectively. What will be the value of θ for the following refraction?



(a) $\sin \theta \geq \frac{13}{11}$ (b) $\sin \theta \geq \frac{11}{13}$
 (c) $\sin \theta \geq \frac{\sqrt{3}}{2}$ (d) $\sin \theta \geq \frac{1}{\sqrt{2}}$

3. A prism having an apex angle 4° and refraction index 1.5 is located in front of a vertical plane mirror as shown in the figure. Through what total angle is the ray deviated after reflection from the mirror



(a) 176° (b) 4° (c) 178° (d) 2°

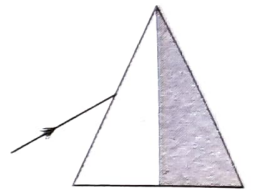
4. A light ray is incident by grazing one of the face of a prism and after refraction ray does not emerge out, what should be the angle of prism while critical angle is C ?

(a) Equal to $2C$ (b) Less than $2C$
 (c) More than $2C$ (d) None of the above

5. The light ray is incidence at angle of 60° on a prism of angle 45° . When the light ray falls on the other surface at 90° , the refractive index of the material of prism μ and the angle of deviation δ are given by

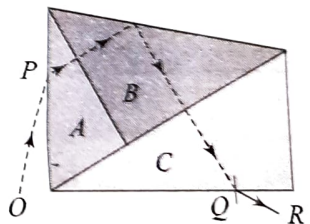
(a) $\mu = \sqrt{2}$, $\delta = 30^\circ$ (b) $\mu = 1.5$, $\delta = 15^\circ$
 (c) $\mu = \frac{\sqrt{3}}{2}$, $\delta = 30^\circ$ (d) $\mu = \frac{\sqrt{3}}{2}$, $\delta = 15^\circ$

6. A light ray is incident upon a prism in minimum deviation position and suffers a deviation of 34° . If the shaded half of the prism is knocked off, the ray will
- (a) suffer a deviation of 34°
 (b) suffer a deviation of 68°
 (c) suffer a deviation of 17°
 (d) not come out of the prism



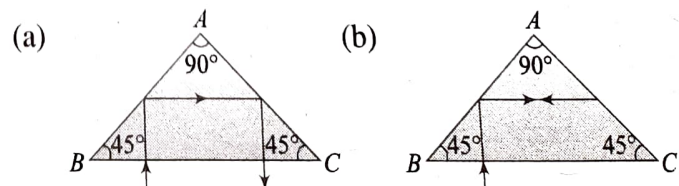
7. A ray of monochromatic light is incident on one refracting face of a prism of angle 75° . It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is
- (a) 30° (b) 45° (c) 60° (d) 0°

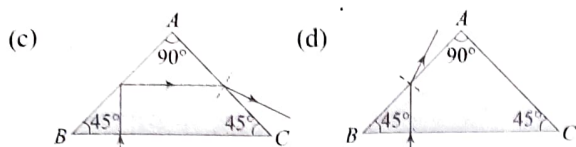
8. Three glass prisms A, B and C of the same refractive index are placed in contact with each other as shown in the figure, with no air gap between the prisms. Monochromatic ray of light OP passes through the prism assembly and emerges as QR. The conditions of minimum deviation is satisfied in the prisms



(a) A and C (b) B and C
 (c) A and B (d) In all prisms A, B and C

9. The refractive index of a material of a prism of angles $45^\circ - 45^\circ - 90^\circ$ is 1.5. The path of the ray of light incident normally on the hypotenuse side is shown in

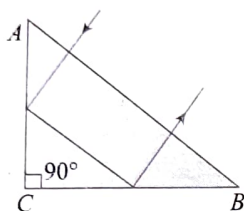




10. Angle of prism is A and its one surface is silvered. Light rays falling at an angle of incidence $2A$ on the first surface return back through the same path after suffering reflection at the second silvered surface. Refractive index of the material of prism is

(a) $2 \sin A$ (b) $2 \cos A$ (c) $\frac{1}{2} \cos A$ (d) $\tan A$

11. A ray of light incident normally on an isosceles right angled prism travels as shown in the figure. The least value of the refractive index of the prism must be



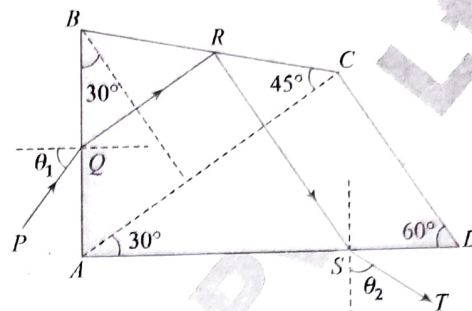
(a) $\sqrt{2}$ (b) $\sqrt{3}$ (c) 1.5 (d) 2.0

12. When a ray of light is incident normally on one refracting surface of an equilateral prism (Refractive index of the material of the prism = 1.5).

(a) Emerging ray is deviated by 30°
 (b) Emerging ray is deviated by 45°
 (c) Emerging ray just grazes the second refracting surface
 (d) The ray undergoes total internal reflection at the second refracting surface

Comprehension Type

Read the paragraph and the figure carefully and answer the questions.



The figure shows a constant deviation prism $ABCD$. The incident ray is PQ and the emergent ray is ST . Although it is made up of one piece of glass, it is equivalent to two $30^\circ - 60^\circ - 90^\circ$ prisms and one $45^\circ - 45^\circ - 90^\circ$ prism. The angle θ_1 is the angle of incidence on face AB . The path of the ray inside the prism is indicated in the figure.

For this prism, $\mu = 2 \sin \theta_1$.

13. The ratio of $\frac{\theta_1}{\theta_2}$ is

(a) 1 (b) $\frac{1}{2}$ (c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

14. The total deviation of the incident ray when it emerges out of the prism is

(a) 90° (b) 60° (c) 30° (d) 45°

15. The angle of refraction on the face AB is

(a) 30° (b) 45° (c) 15° (d) 40°

Answers Key

Single Correct Answer Type

1. (d) 2. (b) 3. (c) 4. (c) 5. (d)
 6. (c) 7. (b) 8. (c) 9. (a) 10. (b)
 11. (a) 12. (d)

Comprehension Type

13. (a) 14. (a) 15. (a)

DPP 1.6

Optical Instruments

Single Correct Answer Type

- A simple telescope, consisting of an objective of focal length 60 cm and a single eye lens of focal length 5 cm is focussed on a distant object in such a way that parallel rays comes out from the eye lens. If the object subtends an angle 2° at the objective, the angular width of the image
 - 10°
 - 24°
 - 50°
 - $1/6^\circ$
- The focal length of objective and eye lens of a astronomical telescope are respectively 2 m and 5 cm. Final image is formed at (i) least distance of distinct vision (ii) infinity. The magnifying power in both cases will be
 - 48, -40
 - 40, -48
 - 40, 48
 - 48, 40
- A compound microscope has an eye piece of focal length 10 cm and an objective of focal length 4 cm. Calculate the magnification if an object is kept at a distance of 5 cm from the objective so that final image is formed at the least distance vision (25 cm)
 - 12
 - 11
 - 10
 - 13
- The length of the compound microscope is 14 cm. The magnifying power for relaxed eye is 25. If the focal length of eye lens is 5 cm, then the object distance for objective lens will be
 - 1.8 cm
 - 1.5 cm
 - 2.1 cm
 - 2.4 cm
- If the focal length of objective and eye lens are 1.2 cm and 3 cm respectively and the object is put 1.25 cm away from the objective lens and the final image is formed at infinity. The magnifying power of the microscope is
 - 150
 - 200
 - 250
 - 400
- The focal length of objective and eye lens of a microscope are 4 cm and 8 cm respectively. If the least distance of distinct vision is 24 cm and object distance is 4.5 cm from the objective lens, then the magnifying power of the microscope will be
 - 18
 - 32
 - 64
 - 20
- In an astronomical telescope in normal adjustment, a straight black line of length L is drawn on the objective lens. The eyepiece forms a real image of this line. The length of this image is l . The magnification of the telescope is
 - $\frac{L}{l}$
 - $\frac{L}{l} + 1$
 - $\frac{L}{l} - 1$
 - $\frac{L + l}{L - l}$
- A telescope uses light having wavelength $5000 \text{ \AA}$ and uses lenses of focal 2.5 and 30 cm. If the diameter of the aperture of the objective is 10 cm, then the resolving limit and magnifying power of the telescope is respectively
 - 6.1×10^{-6} rad and 12
 - 5.0×10^{-6} rad and 12
 - 6.1×10^{-6} rad and 8.3×10^{-2}
 - 5.0×10^{-6} rad and 8.3×10^{-2}
- The diameter of moon is 3.5×10^3 km and its distance from the earth is 3.8×10^3 km. If it is seen through a telescope whose focal length for objective and eye lens are 4 m and 10 cm respectively, then the angle subtended by the moon on the eye will be approximately
 - 15°
 - 20°
 - 30°
 - 35°
- The focal length of an objective of a telescope is 3 metre and diameter 15 cm. Assuming for a normal eye, the diameter of the pupil is 3 mm for its complete use, the focal length of eye piece must be
 - 6 cm
 - 6.3 cm
 - 20 cm
 - 60 cm
- A telescope has an objective lens of 10 cm diameter and is situated at a distance of one kilometre from two objects. The minimum distance between these two objects, which can be resolved by the telescope, when the mean wavelength of light is $5000 \text{ \AA}$, is of the order of
 - 0.5 m
 - 5 m
 - 5 mm
 - 5 cm
- If the focal length of the objective lens and the eye lens are 4 mm and 25 mm respectively in a compound microscope. The length of the tube is 16 cm. Find its magnifying power for relaxed eye position
 - 32.75
 - 327.5
 - 0.3275
 - None of the above

Answers Key

Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|--------|--------|---------|
| 1. (b) | 2. (a) | 3. (a) | 4. (a) | 5. (b) | 6. (b) | 7. (a) | 8. (a) | 9. (b) | 10. (a) |
| | | | | | 11. (c) | 12. (b) | | | |

Wave Optics

DPP 2.1

Wave Nature and Basic Theory of Interference of Light

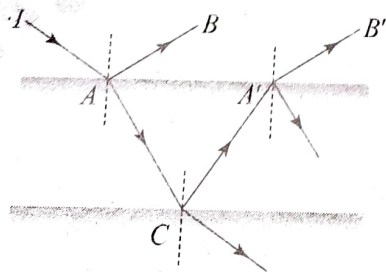
Single Correct Answer Type

- The ratio of intensities of two waves is 9 : 1. They are producing interference. The ratio of maximum and minimum intensities will be
(a) 10 : 8 (b) 9 : 1 (c) 4 : 1 (d) 2 : 1
- Four different independent waves are represented by
(i) $y_1 = a_1 \sin \omega t$ (ii) $y_2 = a_2 \sin 2 \omega t$

(iii) $y_3 = a_3 \sin \omega t$ (iv) $y_4 = a_4 \sin \left(\omega t + \frac{\pi}{3} \right)$

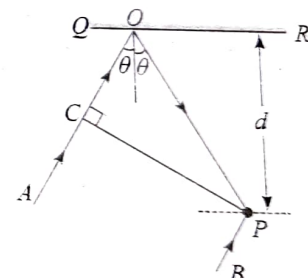
With which two waves interference is possible

- (a) In (i) and (iii) (b) In (i) and (iv)
(c) In (iii) and (iv) (d) Insufficient data to predict
- A ray of light of intensity I is incident on a parallel glass-slab at a point A as shown in the figure. It undergoes partial reflection and refraction. At each reflection 25% of incident energy is reflected. The rays AB and $A'B'$ undergo interference. The ratio $I_{\max}/I_{\min}$ is



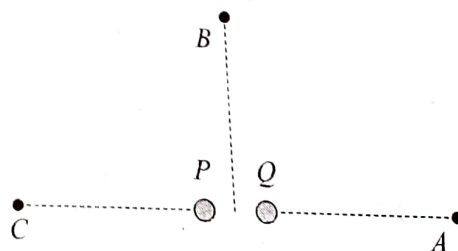
- (a) 4 : 1 (b) 8 : 1 (c) 7 : 1 (d) 49 : 1

- In the adjacent diagram, CP represents a wavefront and AO and BP , the corresponding two rays. Find the condition on θ for constructive interference at P between the ray BP and reflected ray OP



- (a) $\cos \theta = 3\lambda/2d$
(b) $\cos \theta = \lambda/4d$
(c) $\sec \theta - \cos \theta = \lambda/d$
(d) $\sec \theta - \cos \theta = 4\lambda/d$

- Figure here shows P and Q as two equally intense coherent sources emitting radiations of wavelength 20 m. The separation PQ is 5.0 m and phase of P is ahead of the phase of Q by 90° . A , B and C are three distant points of observation equidistant from the mid-point of PQ . The intensity of radiations at A , B , C will bear the ratio

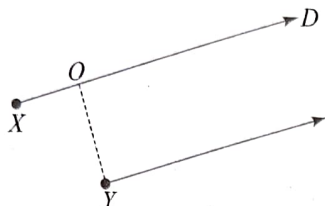


- (a) 0 : 1 : 4 (b) 4 : 1 : 0
(c) 0 : 1 : 2 (d) 2 : 1 : 0

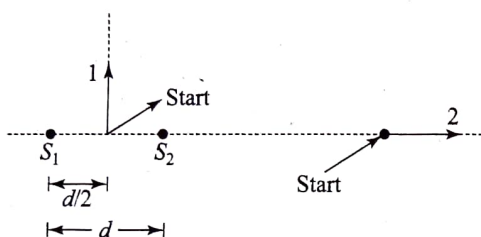
2.2 Optics and Modern Physics

6. Two point sources X and Y emit waves of the same frequency and speed but Y lags in phase behind X by 2π radian. If there is a maximum in direction D the distance XO using n as an integer is given by

- (a) $\frac{\lambda}{2}(n-1)$
 (b) $\lambda(n+1)$
 (c) $\frac{\lambda}{2}(n+1)$
 (d) $\lambda(n-1)$

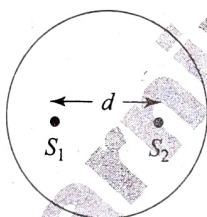


7. Following figure shows sources S_1 and S_2 that emit light of wavelength λ in all directions. The sources are exactly in phase and are separated by a distance equal to 1.5λ . If we start at the indicated start point and travel along paths 1 and 2, the interference produce a maxima all along



- (a) Path 1
 (b) Path 2
 (c) Any path
 (d) None of these

8. Two coherent sources separated by distance d are radiating in phase having wavelength λ . A detector moves in a big circle around the two sources in the plane of the two sources. The angular position of $n=4$ interference maxima is given as



- (a) $\sin^{-1} \frac{n\lambda}{d}$
 (b) $\cos^{-1} \frac{4\lambda}{d}$
 (c) $\tan^{-1} \frac{d}{4\lambda}$
 (d) $\cos^{-1} \frac{\lambda}{4d}$

9. Two coherent sources S_1 and S_2 are separated by a distance four times the wavelength λ of the source. The sources lie along y -axis, whereas a detector moves along $+x$ -axis. Leaving the origin and far off points the number of points where maxima are observed is

- (a) 2
 (b) 3
 (c) 4
 (d) 5

10. Three waves of equal frequency having amplitudes $10\mu\text{m}$, $4\mu\text{m}$, $7\mu\text{m}$ arrive at a given point with successive phase difference of $\frac{\pi}{2}$, the amplitude of the resulting wave in μm is given by

- (a) 4
 (b) 5
 (c) 6
 (d) 7

11. Two identical radiators have a separation of $d = \lambda/4$ where λ is the wavelength of the waves emitted by either source. The initial phase difference between the sources is $\pi/4$. Then the intensity on the screen at a distant point situated

at an angle $\theta = 30^\circ$ from the radiators is (here I_o is intensity at that point due to one radiator alone)

- (a) I_o
 (b) $2I_o$
 (c) $3I_o$
 (d) $4I_o$

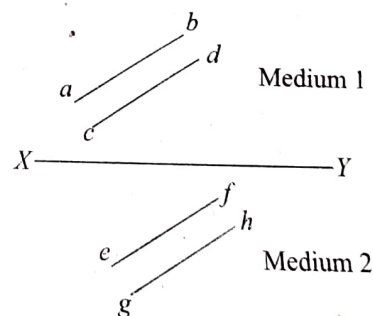
Matching Column Type

12. Column I shows the optical devices on which parallel rays fall. Column II shows the shape of emergent wavefronts. Match them.

	Column I		Column II
(A)		(P)	
(B)		(Q)	
(C)		(R)	
(D)		(S)	

Comprehension Type

The figure shows a surface XY separating two transparent media. Medium I and medium II. The lines ab and cd represent wave fronts of a light wave travelling in medium I and incident on XY . The lines ef and gh represent wavefronts of the light wave in medium 2 after refraction.



13. Light travels as a:

- (a) parallel beam in each medium
 (b) convergent beam in each medium
 (c) divergent beam in each medium
 (d) divergent beam in one medium and convergent beam in other medium.

14. The phase of light wave at c , d , e and f are ϕ_c , ϕ_d , ϕ_e and ϕ_f respectively. It is given that $\phi_c \neq \phi_f$
- ϕ_c cannot be equal to ϕ_d
 - ϕ_d can be equal to ϕ_e
 - $(\phi_d - \phi_f)$ is equal to $(\phi_c - \phi_e)$
 - $(\phi_d - \phi_c)$ is not equal to $(\phi_f - \phi_e)$

15. Speed of light is
- the same in medium 1 and medium 2
 - larger in medium 1 than in medium 2
 - larger in medium 2 than in medium 1
 - different at b and d

Answers Key

Single Correct Answer Type

- | | | | | |
|---------|--------|--------|--------|---------|
| 1. (c) | 2. (d) | 3. (d) | 4. (b) | 5. (d) |
| 6. (b) | 7. (a) | 8. (b) | 9. (b) | 10. (b) |
| 11. (b) | | | | |

Matching Column Type

12. (A) $\rightarrow$ S; (B) $\rightarrow$ R; (C) $\rightarrow$ P; (D) $\rightarrow$ S

Comprehension Type

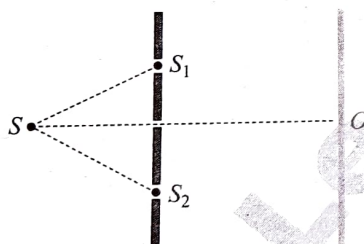
13. (a) 14. (c) 15. (b)

DPP 2.2

Young's Double Slit Experiment (Basic)

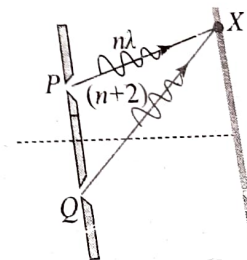
Single Correct Answer Type

- In Young's double slit experiment, if the two slits are illuminated with separate sources, no interference pattern is observed because
 - there will be no constant phase difference between the two waves
 - the wavelengths are not equal
 - the amplitudes are not equal
 - none of the above
- In Young's double slit experiment, if monochromatic light is replaced by white light
 - All bright fringes become white
 - All bright fringes have colours between violet and red
 - Only the central fringe is white, all other fringes are coloured
 - No fringes are observed
- In the set up shown in the figure the two slits S_1 and S_2 are not equidistant from the slit S . The central fringe at O is then
 - always bright
 - always dark
 - either dark or bright depending on the position of S
 - neither dark nor bright.
- The maximum intensity of fringes in Young's experiment is I . If one of the slit is closed, then the intensity at that place becomes I_0 . Which of the following relation is true?
 - $I = I_0$
 - $I = 2I_0$
 - $I = 4I_0$
 - There is no relation between I and I_0
- In Young's double slit experiment, if the slit widths are in the ratio 1 : 9, then the ratio of the intensity at minima to that at maxima will be
 - 1
 - 1/9
 - 1/4
 - 1/3
- In Young's double slit experiment, the intensity on the screen at a point where path difference is λ is K . What will be the intensity at the point where path difference is $\lambda/4$?



- (a) $\frac{K}{4}$ (b) $\frac{K}{2}$ (c) K (d) Zero

- The maximum intensity in Young's double slit experiment is I_0 . Distance between the slits is $d = 5\lambda$, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance $D = 10d$?
 - $\frac{I_0}{2}$
 - $\frac{3}{4}I_0$
 - I_0
 - $\frac{I_0}{4}$
- The two coherent sources of equal intensity produce maximum intensity of 100 units at a point. If the intensity of one of the sources is reduced by 36% by reducing its width, then the intensity of light at the same point will be
 - 90
 - 89
 - 67
 - 81
- In a Young's double slit experiment, I_0 is the intensity at the central maximum and β is the fringe width. The intensity at a point P distant x from the centre will be
 - $I_0 \cos \frac{\pi x}{\beta}$
 - $4I_0 \cos^2 \frac{\pi x}{\beta}$
 - $I_0 \cos^2 \frac{\pi x}{\beta}$
 - $\frac{I_0}{4} \cos^2 \frac{\pi x}{\beta}$
- The path difference between two interfering waves of equal intensities at a point on the screen is $\frac{\lambda}{4}$. The ratio of intensity at this point and that at the central fringe will be
 - 1 : 1
 - 1 : 2
 - 2 : 1
 - 1 : 4
- In Young's double slit experiment, we get 60 fringes in the field of view of monochromatic light of wavelength $4000 \text{ \AA}$. If we use monochromatic light of wavelength $6000 \text{ \AA}$, then the number of fringes obtained in the same field of view is
 - 60
 - 90
 - 40
 - 1.5
- The figure shows a double slit experiment, P and Q are the slits. The path lengths PX and QX are $n\lambda$ and $(n+2)\lambda$ respectively, where n is a whole number and λ is the wavelength. Taking the central fringe as zero, what is formed at X
 - First bright
 - First dark
 - Second bright
 - Second dark



13. In a two-slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} m. If separation between the slits is 10^{-3} m, the wavelength of light used is
 (a) 6000 Å (b) 5000 Å
 (c) 3000 Å (d) 4500 Å
14. In Young's double slit experiment how many maxima can be obtained on a screen (including the central maximum) on both sides of the central fringe if $\lambda = 2000$ Å and $d = 7000$ Å
 (a) 12 (b) 7 (c) 18 (d) 4

Multiple Correct Answers Type

15. In a Young's double slit experiment, the separation between the two slits is d and wavelength of light is λ . The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Find the correct choices.
 (a) If $d = \lambda$, the screen will contain one maximum
 (b) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central maximum) will be observed on the screen
 (c) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2 the intensities of the observed dark and bright fringes will increase
 (d) If the intensity of light falling off on slit 2 is increased so that it becomes equal to that of slit 1, the intensity of the observed dark and bright fringes will increase

Answers Key

Single Correct Answer Type

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (a) | 2. (c) | 3. (c) | 4. (c) | 5. (c) |
| 6. (b) | 7. (a) | 8. (d) | 9. (c) | 10. (b) |
| 11. (c) | 12. (c) | 13. (a) | 14. (b) | |

Multiple Correct Answers Type

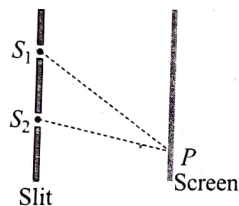
15. (a, b)

DPP 2.3

Introduction of Mica Sheet in Young's Double Slit Experiment

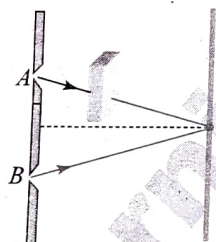
Single Correct Answer Type

1. In a Young's double slit experimental arrangement shown here, if a mica sheet of thickness t and refractive index μ is placed in front of the slit S_1 , then the path difference ($S_1P - S_2P$)



- (a) Decreases by $(\mu - 1)t$
 (b) Increases by $(\mu - 1)t$
 (c) Does not change
 (d) Increases by μt

2. In Young's experiment, monochromatic light is used to illuminate the two slits A and B . Interference fringes are observed on a screen placed in front of the slits. Now if a thin glass plate is placed normally in the path of the beam coming from the slit



- (a) the fringes will disappear
 (b) the fringe width will increase
 (c) the fringe width will increase
 (d) there will be no change in the fringe width but the pattern shifts

3. A thin mica sheet of thickness 2×10^{-6} and refractive index ($\mu = 1.5$) is introduced in the path of the first wave. The wavelength of the wave used is $5000 \text{ \AA}$. The central bright maximum will shift

- (a) 2 fringes upward (b) 2 fringes downward
 (c) 10 fringes upward (d) None of these

4. When one of the slits of Young's experiment is covered with a transparent sheet of thickness 4.8 mm , the central fringe shifts to a position originally occupied by the 30^{th} bright fringe. What should be the thickness of the sheet if the central fringe has to shift to the position occupied by 20^{th} bright fringe?

- (a) 3.8 mm (b) 1.6 mm
 (c) 7.6 mm (d) 3.2 mm

5. Light of wavelength 500 nm is used to form interference pattern in Young's double slit experiment. A uniform glass plate of refractive index 1.5 and thickness 0.1 nm is introduced in the path of one of the interfering beams. The number of fringes which will shift the cross wire due to this is

- (a) 100 (b) 200 (c) 300 (d) 400

6. A flake of glass (refractive index 1.5) is placed over one of the openings of a double slit apparatus. The interference pattern displaces itself through seven successive maximas towards the side where the flake is placed. If wavelength of the diffracted light is $\lambda = 600 \text{ nm}$, then the thickness of the flake is

- (a) 2100 nm (b) 4200 nm
 (c) 8400 nm (d) None of these

7. In Young's double slit experiment, the fringes are displaced by a distance x when a glass plate of one refractive index 1.5 is introduced in the path of one of the beams. When this plate is replaced by another plate of the same thickness, the shift of fringes is $(3/2)x$. The refractive index of the second plate is

- (a) 1.75 (b) 1.50 (c) 1.25 (d) 1.00

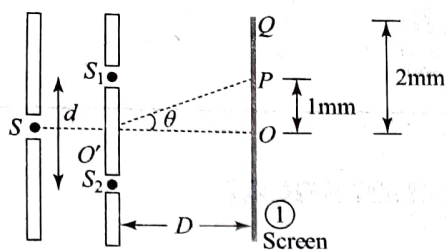
8. In a double slit arrangement fringes are produced using light of wavelength $4800 \text{ \AA}$. One slit is covered by a thin plate of glass of refractive index 1.4 and the other with another glass plate of the same thickness but of refractive index 1.7 . By doing so the central bright shifts to original fifth bright fringe from the centre. Thickness of glass plate is

- (a) $8 \mu\text{m}$ (b) $6 \mu\text{m}$ (c) $4 \mu\text{m}$ (d) $10 \mu\text{m}$

Comprehension Type

In Young's interference experiment has a set up as shown in figure, consider that a source of monochromatic light of wavelength $5000 \text{ \AA}$ is placed at S . S_1 and S_2 are equidistant from S and have equal widths. A wavefront proceeds from S , and S_1 and S_2 , being points on this wavefront, emit light waves, which superimpose to result in an interference pattern on the screen kept at position (1). This is an experiment where coherent sources are obtained by division of wavefront. O is a point on the screen equidistant from S_1 and S_2 . P is a point on the screen 1 mm from O at which path difference between waves from S_1 and S_2 is $11250 \text{ \AA}$. Position of any point on the screen can be expressed by θ .

The path difference is zero at O and a central bright fringe of intensity ' I_0 ' is obtained at O . Q is another point 2 mm from O . If the screen is now shifted to a new position (2) [not shown in figure] so that D changes, the fringe width is found to be 50% more than its earlier value and the angular fringe width is $\frac{1}{90}$ radian.



Answer the following questions [assume D to be large and θ very small so that $\sin \theta \approx \tan \theta \approx \theta$]

9. When the screen is at position (1), phase difference of waves from S_1 and S_2 at point P is effectively
(a) 90° (b) 120° (c) 150° (d) 60°
10. Intensity at P when the screen is at position (1), is
(a) $2I_0$ (b) I_0 (c) $\frac{I_0}{2}$ (d) $\frac{I_0}{4}$
11. Fringe width when screen is at position (1) will be
(a) $\frac{4}{9}$ mm (b) $\frac{3}{5}$ mm (c) $\frac{4}{5}$ mm (d) $\frac{1}{4}$ mm

12. Intensity at point Q when screen is at position (1) is
(a) $0.5 I_0$ (b) $5 I_0$
(c) zero (d) none of these
13. Distance ' d ' between S_1 and S_2 is
(a) 0.2 mm (b) $45 \mu\text{m}$
(c) $20 \mu\text{m}$ (d) none of these
14. When the screen is at position (2), its distance from the double slits is nearly
(a) 30 cm (b) 20 cm
(c) 38 cm (d) none of these
15. Angular position of a bright fringe of order '5' when the screen is at position (1), will be nearly
(a) $\frac{1}{9}$ rad (b) $\frac{1}{18}$ rad
(c) $\frac{1}{10}$ rad (d) none of these

Answers Key

Single Correct Answer Type

1. (b) 2. (d) 3. (a) 4. (d) 5. (a)
6. (c) 7. (a) 8. (a)

Comprehension Type

9. (a) 10. (c) 11. (a) 12. (c) 13. (b)
14. (a) 15. (b)

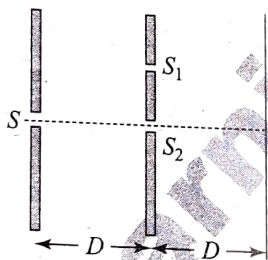
DPP 2.4

Different Cases in Young's Double Slit Experiment

Single Correct Answer Type

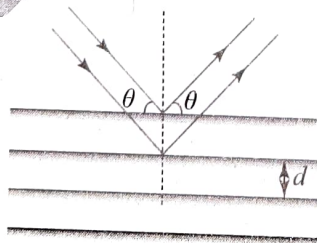
1. The Young's experiment is performed with the lights of blue ($\lambda = 4360 \text{ \AA}$) and green colour ($\lambda = 5460 \text{ \AA}$). If the distance of the 4th fringe from the centre is x , then
 (a) $x(\text{Blue}) = x(\text{Green})$ (b) $x(\text{Blue}) > x(\text{Green})$
 (c) $x(\text{Blue}) < x(\text{Green})$ (d) $\frac{x(\text{Blue})}{x(\text{Green})} = \frac{5460}{4360}$
2. Two ideal slits S_1 and S_2 are at a distance d apart and illuminated by light of wavelength λ passing through an ideal source slit S placed on the line through S_2 as shown. The distance between the planes of slits and the source slit is D . A screen is held at a distance D from the plane of the slits. The minimum value of d for which there is darkness at O is

- (a) $\sqrt{\frac{3\lambda D}{2}}$
 (b) $\sqrt{\lambda D}$
 (c) $\sqrt{\frac{\lambda D}{2}}$
 (d) $\sqrt{3\lambda D}$



3. A beam with wavelength λ falls on a stack of partially reflecting planes with separation d . The angle θ that the beam should make with the planes so that the beams reflected from successive planes may interfere constructively is (where $n = 1, 2, \dots$)

- (a) $\sin^{-1}\left(\frac{n\lambda}{d}\right)$
 (b) $\tan^{-1}\left(\frac{n\lambda}{d}\right)$
 (c) $\sin^{-1}\left(\frac{n\lambda}{2d}\right)$
 (d) $\cos^{-1}\left(\frac{n\lambda}{2d}\right)$



4. White light may be considered to be a mixture of waves with λ ranging between $3900 \text{ \AA}$ and $7800 \text{ \AA}$. An oil film of thickness $10,000 \text{ \AA}$ is examined normally by reflected light. If $\mu = 1.4$, then the film appears bright for
 (a) $4308 \text{ \AA}$, $5091 \text{ \AA}$, $6222 \text{ \AA}$
 (b) $4000 \text{ \AA}$, $5091 \text{ \AA}$, $5600 \text{ \AA}$

- (c) $4667 \text{ \AA}$, $6222 \text{ \AA}$, $7000 \text{ \AA}$
 (d) $4000 \text{ \AA}$, $4667 \text{ \AA}$, $5600 \text{ \AA}$, $7000 \text{ \AA}$

5. A light of wavelength $5890 \text{ \AA}$ falls normally on a thin air film. The minimum thickness of the film such that the film appears dark in reflected light
 (a) $2.945 \times 10^{-7} \text{ m}$ (b) $3.945 \times 10^{-7} \text{ m}$
 (c) $4.95 \times 10^{-7} \text{ m}$ (d) $1.945 \times 10^{-7} \text{ m}$
6. What is the effect on Fresnel's biprism experiment when the use of white light is made?
 (a) Fringes are affected
 (b) Diffraction pattern is spread more
 (c) Central fringe is white and all are coloured
 (d) None of these
7. In a biprism experiment, by using light of wavelength $5000 \text{ \AA}$, 5 mm wide fringes are obtained on a screen 1.0 m away from the coherent sources. The separation between the two coherent sources is
 (a) 1.0 mm (b) 0.1 mm
 (c) 0.05 mm (d) 0.01 mm
8. In Fresnel's biprism ($\mu = 1.5$) experiment, the distance between source and biprism is 0.3 m and that between biprism and screen is 0.7 m and angle of prism is 1° . The fringe width with light of wavelength $6000 \text{ \AA}$ will be
 (a) 3 cm (b) 0.011 cm
 (c) 2 cm (d) 4 cm

Matching Column Type

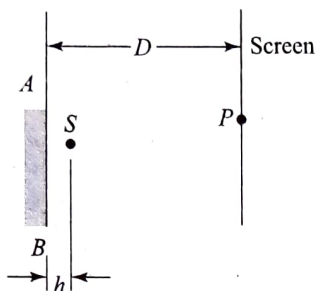
9. In Young's double slit experiment, two slits are illuminated with separation between them as b . The screen is at a distance d ($\gg b$) from slits. At a point P on the screen directly in front of one of the slits, certain wavelengths are missing. Match the options of the columns.

	Column I		Column II
(A)	At P , wavelength (b^2/d) is	(P)	missing
(B)	At P , wavelength ($b^2/5d$) is	(Q)	not missing
(C)	Wavelength ($2b^2/3d$) is missing at a point Q on screen which is at a distance X_1 from central maxima	(R)	$X_1 = b$
(D)	The wavelength ($2b^2/3d$) at a point on screen at some other distance ($b/3$) from central maxima.	(S)	$X_1 = \frac{3b}{4}$

Comprehension Type

For Problems 10–12

A point source S emits light of wavelength 600 nm. It is placed at a very small distance from a flat reflecting mirror AB . Interference fringes as observed on the screen placed parallel to reflecting surface at very large distance D from it. The ratio of minimum to maximum intensities in the interference fringes formed near the point P is $1/6$

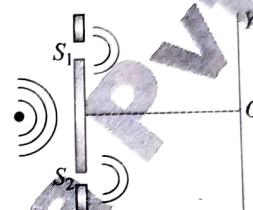


10. What is the shape of interference fringes on the screen?
(a) elliptical (b) paraboloid
(c) circular (d) none of these
11. What is the percentage intensity of the reflected light to the intensity of the incident light?
(a) 49% (b) 64% (c) 81% (d) 36%
12. If the intensity of P corresponds to a maximum, calculate the minimum distance through which the reflecting surface AB should be shifted so that intensity at P again becomes maximum.

- (a) 150 nm (b) 300 nm
(c) 450 nm (d) 575 nm

For Problems 13–15

In YDSE's experiment performed in a medium of refractive index $(4/3)$, a light of 60 nm wavelength is falling on the slits having 0.45 mm separation. The lower slit S_2 is covered by a thin glass sheet of thickness $10.4 \mu\text{m}$ and refractive index 1.5. The interference pattern is observed on a screen placed 1.5 m from the slits as shown in the figure. Ignore dispersion.



13. Find the location of central maxima on y-axis.
(a) 5.37 mm (b) 4.33 mm
(c) 3.78 mm (d) 3.15 mm
14. Find the light intensity of point O relative to maximum fringe intensity.
(a) $0.6 I_{\max}$ (b) $0.75 I_{\max}$
(c) $0.8 I_{\max}$ (d) $0.9 I_{\max}$
15. If white light of range 400–700 nm has replaced 600 nm light, one of the wavelengths of light that forms maxima exactly at point O will be:
(a) 650 nm (b) 625 nm
(c) 550 nm (d) 605 nm

Answers Key

Single Correct Answer Type

1. (c) 2. (c) 3. (c) 4. (a) 5. (a)
6. (c) 7. (b) 8. (b)

Comprehension Type

10. (c) 11. (d) 12. (b) 13. (b) 14. (b)
15. (a)

Matching Column Type

9. (A) $\rightarrow$ P; (B) $\rightarrow$ P; (C) $\rightarrow$ R; (D) $\rightarrow$ P

Electrons, Photons, Photoelectric Effect and X-Rays

DPP 3.1

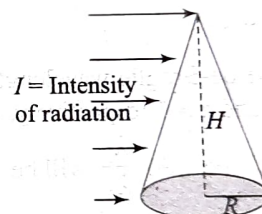
Radiation Pressure and Matter Waves

Subjective Type

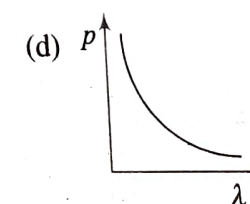
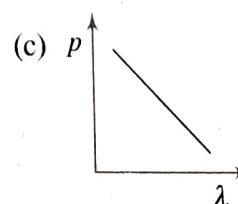
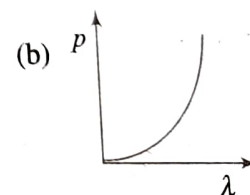
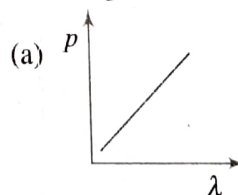
1. An electron (mass m) with an initial velocity $v = v_0 \hat{i}$ ($v_0 > 0$) is in an electric field $E = -E_0 \hat{i}$ ($E_0 = \text{constant} > 0$). Its de-Broglie wavelength at time t is given by

Single Correct Answer Type

2. A silver ball of radius 4.8 cm is suspended by a thread in the vacuum chamber. UV light of wavelength 200 nm is incident on the ball for some times during which a total energy of 1×10^{-7} J falls on the surface. Assuming on an average one out of 10^3 photons incident is able to eject electron. The potential on sphere will be
(a) 1 V (b) 2 V (c) 3 V (d) Zero
3. The minimum intensity of light to be detected by human eye is 10^{-10} W/m². The number of photons of wavelength 5.6×10^{-7} m entering the eye, with pupil area 10^{-6} m², per second for vision will be nearly
(a) 100 (b) 200 (c) 300 (d) 400
4. The eye can detect 5×10^4 photons per square metre per sec of green light ($\lambda = 5000 \text{ \AA}$) while the ear can detect 10^{-13} (W/m²). The factor by which the eye is more sensitive as a power detector than the ear is close to
(a) 5 (b) 10 (c) 10^6 (d) 15
5. The radiation force experienced by body exposed to radiation of intensity I , assuming surface of body to be perfectly absorbing is:



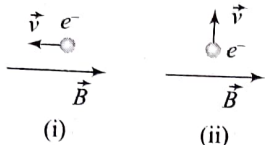
- (a) $\frac{\pi R^2 I}{c}$ (b) $\frac{\pi R^2 I}{2c}$ (c) $\frac{IRH}{2c}$ (d) $\frac{IRH}{c}$
6. Radiation pressure on any surface:
 - (a) is dependent on wavelength of the light used
 - (b) is dependent on nature of surface and intensity of light used
 - (c) is dependent on frequency and nature of surface
 - (d) depends on the nature of source from which light is coming and on nature of surface on which it is falling
 7. Which of the following figure represents the variation of particle momentum and the associated de-Broglie wavelength?



3.2 Optics and Modern Physics

8. An electron is moving through a field. It is moving (i) opposite an electric field (ii) perpendicular to a magnetic field as shown. For each situation the de-Broglie wavelength of electron

- (a) Increasing, increasing
(b) Increasing, decreasing
(c) Decreasing, same
(d) Same, same



(i) (ii)

9. The energy that should be added to an electron to reduce its de-Broglie wavelength from 1 nm to 0.5 nm is

- (a) four times the initial energy
(b) equal to the initial energy
(c) twice the initial energy
(d) thrice the initial energy

10. A particle of mass M at rest decays into two particles of masses m_1 and m_2 , having non-zero velocities. The ratio of the de-Broglie wavelengths of the particles, λ_1/λ_2 is

- (a) m_1/m_2 (b) m_2/m_1 (c) 1.0 (d) $\sqrt{m_2}/\sqrt{m_1}$

11. The ratio of de-Broglie wavelengths of molecules of hydrogen and helium which are at temperature 27°C and 127°C respectively is

- (a) $\frac{1}{2}$ (b) $\sqrt{\frac{3}{8}}$ (c) $\sqrt{\frac{8}{3}}$ (d) 1

12. The potential energy of a particle of mass m is given by

$$U(x) = \begin{cases} E_0; & 0 \leq x \leq 1 \\ 0; & x > 1 \end{cases}$$

λ_1 and λ_2 are the de-Broglie wavelengths of the particle, when $0 \leq x \leq 1$ and $x > 1$ respectively. If the total energy of particle is $2E_0$, the ratio $\frac{\lambda_1}{\lambda_2}$ will be

- (a) 2 (b) 1 (c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

13. If the momentum of an electron is changed by Δp , then the de-Broglie wavelength associated with it changes by 0.50%. The initial momentum of the electron will be

- (a) $\frac{\Delta p}{200}$ (b) $\frac{\Delta p}{199}$ (c) $199 \Delta p$ (d) $400 \Delta p$

Multiple Correct Answers Type

14. A particle moves in a closed orbit around the origin, due to a force which is directed towards the origin. The de-Broglie wavelength of the particle varies cyclically between two values λ_1 and λ_2 with $\lambda_1 > \lambda_2$. Which of the following statement are true?

- (a) The particle could be moving in a circular orbit with origin as centre
(b) The particle could be moving in an elliptic orbit with origin as its focus
(c) When the de-Broglie wavelength is λ_1 the particle is nearer the origin than when its value is λ_2
(d) When the de-Broglie wavelength is λ_2 , the particle is nearer the origin than when its value is λ_1

15. Two particles A_1 and A_2 of masses m_1 and m_2 ($m_1 > m_2$) have the same de-Broglie wavelength. Then,

- (a) their momenta are the same
(b) their energies are the same
(c) energy of A_1 is less than the energy of A_2
(d) energy of A_1 is more than the energy of A_2

Answers Key

Subjective Type

1. $\frac{\lambda_0}{\left[1 + \frac{eE_0}{mv_0}t\right]}$

Single Correct Answer Type

2. (c) 3. (c) 4. (a) 5. (d) 6. (b)
7. (d) 8. (c) 9. (d) 10. (c) 11. (c)
12. (c) 13. (c)

Multiple Correct Answers Type

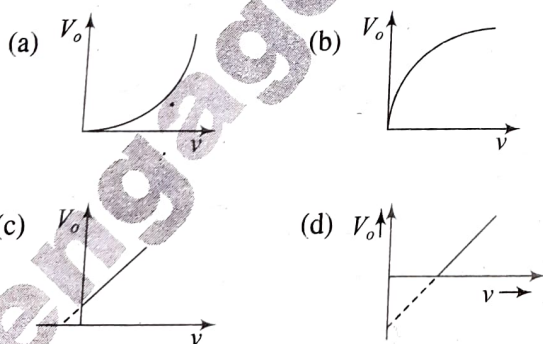
14. (b, d) 15. (a, c)

DPP 3.2

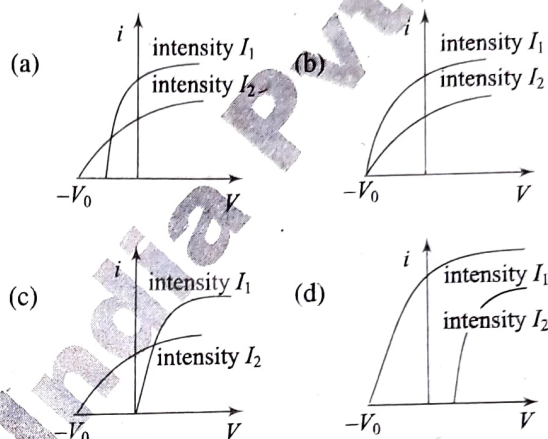
Photoelectric effect 1

Single Correct Answer Type

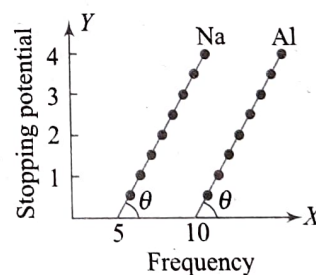
- Which one of the following is true in photoelectric emission
 - Photoelectric current is directly proportional to the amplitude of light of a given frequency
 - Photoelectric current is directly proportional to the intensity of light of a given frequency at moderate intensities
 - Above the threshold frequency, the maximum K.E. of photoelectrons is inversely proportional to the frequency of incident light
 - The threshold frequency depends upon the wavelength of incident light
- If intensity of incident light is increased in photoelectric emission, then which of the following is true
 - Maximum KE of ejected electron will increase
 - Work function will remain unchanged
 - Stopping potential will decrease
 - Maximum KE of ejected electron will decrease
- The cathode of a photoelectric cell is changed such that the work function changes from W_1 to W_2 ($W_2 > W_1$). If the current before and after change are I_1 and I_2 , all other conditions remaining unchanged, then (assuming $h\nu > W_2$)
 - $I_1 = I_2$
 - $I_1 < I_2$
 - $I_1 > I_2$
 - $I_1 < I_2 < 2I_2$
- For a photoelectric cell the graph showing the variation of cut of voltage (V_0) with frequency (ν) of incident light is best represented by



- The curves (a), (b) (c) and (d) show the variation between the applied potential difference (V) and the photoelectric current (i), at two different intensities of light ($I_1 > I_2$). In which figure is the correct variation shown?



- A photo cell is receiving light from a source placed at a distance of 1 m. If the same source is to be placed at a distance of 2 m, then the ejected electron
 - moves with one-fourth energy as that of the initial energy
 - moves with one-fourth of momentum as that of the initial momentum
 - will be half in number
 - will be one-fourth in number
- From the figure describing photoelectric effect we may infer correctly that



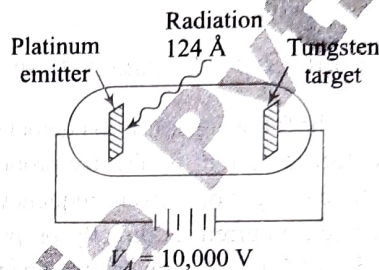
- Na and Al both have the same threshold frequency
 - Maximum kinetic energy for both the metals depends linearly on the frequency
 - The stopping potentials are different for Na and Al for the same change in frequency
 - Al is a better photosensitive material than Na
- Five elements A, B, C, D and E have work functions 1.2 eV, 2.4 eV, 3.6 eV, 4.8 eV and 6 eV respectively. If light of wavelength 4000 Å is allowed to fall on these elements, then photoelectrons are emitted by
 - A, B and C
 - A, B, C, D and E
 - A and B
 - Only E

3.4 Optics and Modern Physics

9. Light of wavelength λ strikes a photosensitive surface and electrons are ejected with kinetic energy E . If the kinetic energy is to be increased to $2E$, the wavelength must be changed to λ' where
- (a) $\lambda' = \frac{\lambda}{2}$ (b) $\lambda' = 2\lambda$
 (c) $\frac{\lambda}{2} < \lambda' < \lambda$ (d) $\lambda' > \lambda$
10. The work functions of metals A and B are in the ratio $1 : 2$. If light of frequencies f and $2f$ are incident on the surfaces of A and B respectively, the ratio of the maximum kinetic energies of photoelectrons emitted is (f is greater than threshold frequency of A , $2f$ is greater than threshold frequency of B)
- (a) $1 : 1$ (b) $1 : 2$ (c) $1 : 3$ (d) $1 : 4$
11. When a metal surface is illuminated by light of wavelengths 400 nm and 250 nm , the maximum velocities of the photoelectrons ejected are v and $2v$ respectively. The work function of the metal is ($h = \text{Planck's constant}$, $c = \text{velocity of light in air}$)
- (a) $2hc \times 10^6 \text{ J}$ (b) $1.5hc \times 10^6 \text{ J}$
 (c) $hc \times 10^6 \text{ J}$ (d) $0.5hc \times 10^6 \text{ J}$
12. A photosensitive metallic surface has work function $h\nu_0$. If photons of energy $2h\nu_0$ fall on this surface the electrons come out with a maximum velocity of $4 \times 10^6 \text{ m/s}$. When the photon energy is increased to $5h\nu_0$, then maximum velocity of photo electron will be
- (a) $2 \times 10^6 \text{ m/s}$ (b) $2 \times 10^7 \text{ m/s}$
 (c) $8 \times 10^5 \text{ m/s}$ (d) $8 \times 10^6 \text{ m/s}$

Comprehension Type

The collector of the photocell (in photoelectric experiment) is made of tungsten while the emitter is of platinum having work function of 10 eV . Monochromatic radiation of wavelength $124 \text{ \AA}$ and power 100 watt is incident on emitter which emits photo electrons with a quantum efficiency of 1% . The accelerating voltage across the photocell is of $10,000 \text{ volts}$ (Use: $h_c = 12400 \text{ eV \AA}$)



13. What is the power supplied by the accelerating voltage source?
- (a) 100 watt (b) 10 watt
 (c) 0.1 watt (d) 1 watt
14. The minimum wavelength of radiation coming from the tungsten target (collector) is
- (a) $124 \text{ \AA}$ (b) $1.24 \text{ \AA}$ (c) $1.23 \text{ \AA}$ (d) $12.3 \text{ \AA}$
15. If the source of monochromatic radiation of wavelength $124 \text{ \AA}$ has an efficiency of 50% , and the power of X-ray emitted by the tungsten target is 3 W , the overall efficiency of the apparatus for X-ray production is
- (a) 1% (b) 0.1% (c) 1.5% (d) 0.67%

Answers Key

Single Correct Answer Type

1. (a) 2. (b) 3. (a) 4. (d) 5. (b)
 6. (d) 7. (b) 8. (c) 9. (c) 10. (b)
 11. (a) 12. (d)

Comprehension Type

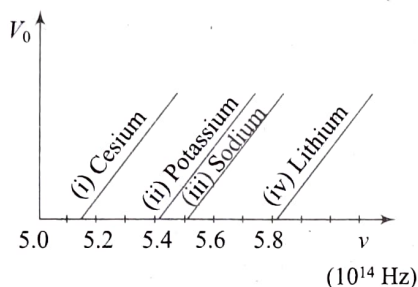
13. (a) 14. (c) 15. (a)

DPP 3.3

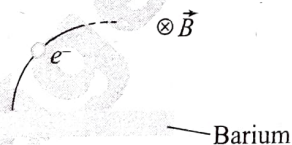
Photoelectric Effect 2

Single Correct Answer Type

1. The figure shows different graphs between stopping potential (V_0) and frequency (ν) for photosensitive surface of cesium, potassium, sodium and lithium. The plots are parallel. Correct ranking of the targets according to their work function greatest first will be

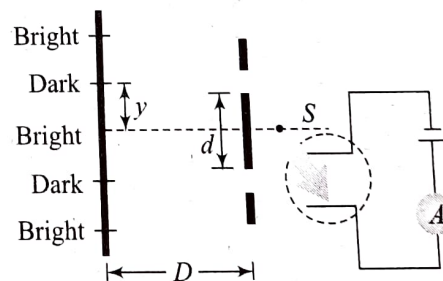


- (a) (i) > (ii) > (iii) > (iv) (b) (i) > (iii) > (ii) > (iv)
 (c) (iv) > (iii) > (ii) < (i) (d) (i) = (iii) > (ii) = (iv)
2. If maximum velocity with which an electron can be emitted from a photo cell is 4×10^8 cm/sec, the stopping potential is (mass of electron = 9×10^{-31} kg)
 (a) 30 volt (b) 45 volt
 (c) 59 volt (d) Information is insufficient
3. Light of wavelength $2475 \text{ \AA}$ is incident on barium. Photoelectrons emitted describe a circle of radius 100 cm by a magnetic field of flux density $\frac{1}{\sqrt{17}} \times 10^{-5}$ Tesla. Work function of the barium is (Given $\frac{e}{m} = 1.7 \times 10^{11}$)



- (a) 1.8 eV (b) 2.1 eV (c) 4.5 eV (d) 3.3 eV
4. If light of wavelength λ_1 is allowed to fall on a metal, then kinetic energy of photoelectrons emitted is E_1 . If wavelength of light changes to λ_2 , then kinetic energy of electrons changes to E_2 . Then work function of the metal is
- (a) $\frac{E_1 E_2 (\lambda_1 - \lambda_2)}{\lambda_1 \lambda_2}$ (b) $\frac{E_1 \lambda_1 - E_2 \lambda_2}{(\lambda_1 - \lambda_2)}$
 (c) $\frac{E_1 \lambda_1 - E_2 \lambda_2}{(\lambda_2 - \lambda_1)}$ (d) $\frac{\lambda_1 \lambda_2 E_1 E_2}{(\lambda_2 - \lambda_1)}$

5. In a photoemissive cell with exciting wavelength λ , the fastest electron has speed v . If the exciting wavelength is changed to $3\lambda/4$, the speed of the fastest emitted electron will be
 (a) $v(3/4)^{1/2}$ (b) $v(4/3)^{1/2}$
 (c) Less than $v(4/3)^{1/2}$ (d) Greater than $v(4/3)^{1/2}$
6. In a photocell bichromatic light of wavelengths $2475 \text{ \AA}$ and $6000 \text{ \AA}$ are incident on cathode whose work function is 4.8 eV. If a uniform magnetic field of 3×10^{-5} Tesla exists parallel to the plate, the radius of the path describe by the photoelectron will be (mass of electron = 9×10^{-31} kg)
 (a) 1 cm (b) 5 cm
 (c) 10 cm (d) 25 cm
7. Two metallic plates A and B, each of area $5 \times 10^{-4} \text{ m}^2$ are placed parallel to each other at a separation of 1 cm. Plate B carries a positive charge of 33.7 pc. A monochromatic beam of light, with photons of energy 5 eV each, starts falling on plate A at $t = 0$, so that 10^{16} photons fall on it per square meter per second. Assume that one photoelectron is emitted for every 10^6 incident photons. Also assume that all the emitted photoelectrons are collected by plate B and the work function of plate A remains constant at the value 2 eV. Electric field between the plates at the end of 10 seconds is
 (a) $2 \times 10^3 \text{ N/C}$ (b) 10^3 N/C
 (c) $5 \times 10^3 \text{ N/C}$ (d) Zero
8. In the following arrangement $y = 1.0 \text{ mm}$, $d = 0.24 \text{ mm}$ and $D = 1.2 \text{ m}$. The work function of the material of the emitter is 2.2 eV. The stopping potential V needed to stop the photocurrent will be



- (a) 0.9 V (b) 0.5 V
 (c) 0.4 V (d) 0.1 V
9. Photoelectric emission is observed from a metallic surface for frequencies ν_1 and ν_2 of the incident light rays ($\nu_1 > \nu_2$). If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio 1 : k, then the threshold frequency of the metallic surface

- (a) $\frac{v_1 - v_2}{k - 1}$ (b) $\frac{kv_1 - v_2}{k - 1}$
 (c) $\frac{kv_2 - v_1}{k - 1}$ (d) $\frac{v_2 - v_1}{k}$

10. Light from a hydrogen discharge tube is incident on the cathode of a photoelectric cell, the work function of the cathode surface is 4.2 eV. In order to reduce the photocurrent to zero the voltage of the anode relative to the cathode must be made

- (a) -4.2 V (b) -9.4 V (c) -17.8 V (d) +9.4 V

11. Work function of lithium and copper are respectively 2.3 eV and 4.0 eV. Which one of the metal will be useful for the photoelectric cell working with visible light? ($h = 6.6 \times 10^{-34}$ J-s, $c = 3 \times 10^8$ m/s)

- (a) Lithium (b) Copper
 (c) Both (d) None of these

12. The work function of a certain metal is $\frac{hc}{\lambda_0}$. When a

monochromatic light of wavelength $\lambda < \lambda_0$ is incident such that the plate gains a total power P . If the efficiency of photoelectric emission is $\eta\%$ and all the emitted photoelectrons are captured by a hollow conducting sphere of radius R already charged to potential V , then neglecting any interaction between plate and the sphere, expression of potential of the sphere at time t is:

- (a) $V + \frac{100\eta\lambda Pet}{4\pi\epsilon_0 RhC}$ (b) $V - \frac{\eta\lambda Pet}{400\pi\epsilon_0 RhC}$
 (c) V (d) $\frac{\lambda Pet}{4\pi\epsilon_0 RhC}$

Comprehension Type

A physicist wishes to eject electrons by shining light on a metal surface. The light source emits light of wavelength of 450 nm. The table lists the only available metals and their work functions.

Metal	Barium	Lithium	Tantalum	Tungsten
W_0 (eV)	2.5	2.3	4.2	4.5

13. Which metal(s) can be used to produce electrons by the photoelectric effect from given source of light?

- (a) Barium only
 (b) Barium or lithium
 (c) Lithium, tantalum or tungsten
 (d) Tungsten or tantalum

14. Which option correctly identifies the metal that will produce the most energetic electrons and their energies?

- (a) Lithium, 0.45 eV
 (b) Tungsten, 1.75 eV
 (c) Lithium, 2.30 eV
 (d) Tungsten, 2.75 eV

15. Suppose photoelectric experiment is done separately with these metals with light of wavelength 450 nm. The maximum magnitude of stopping potential amongst all the metals is

- (a) 2.75 volt (b) 4.5 volt
 (c) 0.45 volt (d) 0.25 volt

Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (c) 4. (c) 5. (d)
 6. (b) 7. (a) 8. (a) 9. (b) 10. (b)
 11. (a) 12. (b)

Comprehension Type

13. (b) 14. (a) 15. (c)

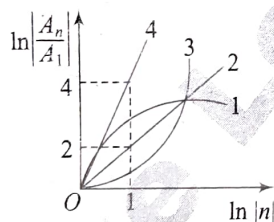
DPP 4.1

Bohr Model of Atomic Structure 1

Single Correct Answer Type

1. The figure shows a graph between $\ln \left| \frac{A_n}{A_1} \right|$ and $\ln |n|$, where

A_n is the area enclosed by the n th orbit in a hydrogen like atom. The correct curve is



- (a) 4 (b) 3 (c) 2 (d) 1
2. In Bohr model of hydrogen atom, the force on the electron depends on the principal quantum number as
 (a) $F \propto 1/n^2$ (b) $F \propto 1/n^4$
 (c) $F \propto 1/n^5$ (d) Does not depend on n
3. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. The spectral lines emitted by hydrogen atoms according to Bohr's theory will be
 (a) One (b) Two (c) Three (d) Four
4. The ratio of ionization energy of Bohr's hydrogen atom and Bohr's hydrogen like lithium atom is
 (a) 1 : 1 (b) 1 : 3
 (c) 1 : 9 (d) None of these
5. What is the angular momentum of an electron in Bohr's hydrogen atom whose energy is -0.544 eV?
 (a) $\frac{h}{\pi}$ (b) $\frac{2h}{\pi}$ (c) $\frac{5h}{2\pi}$ (d) $\frac{7h}{2\pi}$
6. The ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom (both in ground state) is
 (a) 1 (b) 8 (c) 4 (d) 16
7. A hydrogen atom in its ground state absorbs 10.2 eV of energy. The orbital angular momentum is increased by
 (a) 1.05×10^{-34} J-sec (b) 3.16×10^{-34} J-sec
 (c) 2.11×10^{-34} J-sec (d) 4.22×10^{-34} J-sec
 (Given Planck constant $h = 6.6 \times 10^{-34}$ sec)
8. The ratio of the speed of the electrons in the ground state of hydrogen to the speed of light in vacuum is
 (a) $1/2$ (b) $2/137$
 (c) $1/137$ (d) $1/237$
9. Minimum excitation potential of Bohr's first orbit in hydrogen atom is
 (a) 13.6 V (b) 3.4 V
 (c) 10.2 V (d) 3.6 V
10. Which of the following statements are true regarding Bohr's model of hydrogen atom?
 (I) Orbiting speed of electron decreases as it shifts to discrete orbits away from the nucleus
 (II) Radii of allowed orbits of electron are proportional to the principal quantum number

4.2 Optics and Modern Physics

- (III) Frequency with which electrons orbits around the nucleus in discrete orbits is inversely proportional to the principal quantum number
- (IV) Binding force with which the electron is bound to the nucleus increases as it shifts to outer orbits

Select correct answer using the codes given below

Codes:

- (a) I and III (b) II and IV
(c) I, II and III (d) II, III and IV
11. The de-Broglie wavelength of an electron in the first Bohr orbit is
- (a) equal to one-fourth the circumference of the first orbit
(b) equal to half the circumference of the first orbit
(c) equal to twice the circumference of the first orbit
(d) equal to the circumference of the first orbit
12. In a hypothetical Bohr hydrogen, the mass of the electron is doubled. The energy E_0 and the radius r_0 of the first orbit will be (a_0 is the Bohr radius)
- (a) $E_0 = -27.2 \text{ eV}$; $r_0 = a_0/2$
(b) $E_0 = -27.2 \text{ eV}$; $r_0 = a_0$

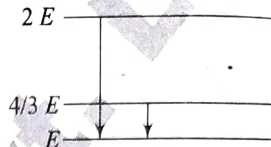
(c) $E_0 = -13.6 \text{ eV}$; $r_0 = a_0/2$

(d) $E_0 = -13.6 \text{ eV}$; $r_0 = a_0$

13. Which of the following transitions in a hydrogen atom emits photon of the highest frequency?

- (a) $n = 1$ to $n = 2$ (b) $n = 2$ to $n = 1$
(c) $n = 2$ to $n = 6$ (d) $n = 6$ to $n = 2$

14. The following diagram indicates the energy levels of a certain atom when the system moves from $2E$ level to E , a photon of wavelength λ is emitted. The wavelength of photon produced during its transition from $\frac{4E}{3}$ level to E is



- (a) $\lambda/3$ (b) $3\lambda/4$ (c) $4\lambda/3$ (d) 3λ

15. A double charged lithium atom is equivalent to hydrogen whose atomic number is 3. The wavelength of required radiation for emitting electron from first to third Bohr orbit in Li^{++} will be (Ionisation energy of hydrogen atom is 13.6 eV)

- (a) $182.51 \text{ \AA}$ (b) $177.17 \text{ \AA}$
(c) $142.25 \text{ \AA}$ (d) $113.74 \text{ \AA}$

Answers Key

Single Correct Answer Type

1. (a) 2. (b) 3. (c) 4. (c) 5. (c)
6. (b) 7. (a) 8. (c) 9. (c) 10. (a)

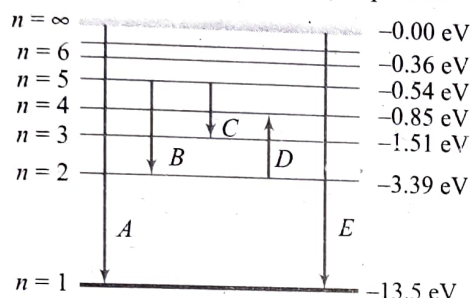
11. (d) 12. (a) 13. (a) 14. (d) 15. (d)

DPP 4.2

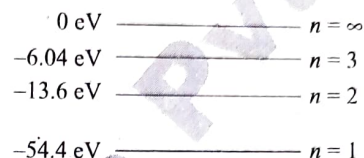
Bohr Model of Atomic Structure 2

Single Correct Answer Type

1. The energy levels of the hydrogen spectrum is shown in the figure. There are some transitions A, B, C, D and E. Transition A, B and C respectively represent

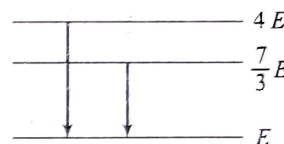


- (a) First member of Lyman series, third spectral line of Balmer series and the second spectral line of Paschen series
 (b) Ionization potential of hydrogen, second spectral line of Balmer series and third spectral line of Paschen series
 (c) Series limit of Lyman series, third spectral line of Balmer series and second spectral line of Paschen series
 (d) Series limit of Lyman series, second spectral line of Balmer series and third spectral line of Paschen series
2. In the above figure D and E respectively represent
- (a) Absorption line of Balmer series and the ionization potential of hydrogen
 (b) Absorption line of Balmer series and the wavelength lesser than lowest of the Lyman series
 (c) Spectral line of Balmer series and the maximum wavelength of Lyman series
 (d) Spectral line of Lyman series and the absorption of greater wavelength of limiting value of Paschen series
3. If the wavelength of the first line of the Balmer series of hydrogen is $6561 \text{ \AA}$, the wavelength of the second line of the series should be
- (a) $13122 \text{ \AA}$ (b) $3280 \text{ \AA}$
 (c) $4860 \text{ \AA}$ (d) $2187 \text{ \AA}$
4. The energy level diagram for an hydrogen like atom is shown in the figure. The radius of its first Bohr orbit is
- (a) $0.265 \text{ \AA}$ (b) $0.53 \text{ \AA}$
 (c) $0.132 \text{ \AA}$ (d) None of these



5. If the series limit of Lyman series for hydrogen atom is equal to the series limit of Balmer series for a hydrogen like atom, then atomic number of this hydrogen like atom will be
- (a) 1 (b) 2 (c) 3 (d) 4

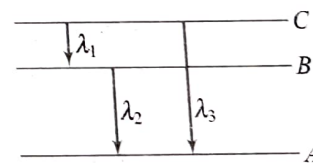
6. The following diagram indicates the energy levels of a certain atom when the system moves from $4E$ level to E . A photon of wavelength λ_1 is emitted. The wavelength of photon produced during its transition from $\frac{7}{3}E$ level to E is λ_2 . The ratio $\frac{\lambda_1}{\lambda_2}$ will be



- (a) $\frac{9}{4}$ (b) $\frac{4}{9}$ (c) $\frac{3}{2}$ (d) $\frac{7}{3}$

7. A hydrogen atom emits a photon corresponding to an electron transition from $n = 5$ to $n = 1$. The recoil speed of hydrogen atom is almost (mass of proton $\approx 1.6 \times 10^{-27} \text{ kg}$).
- (a) 10 ms^{-1} (b) $2 \times 10^{-2} \text{ ms}^{-1}$
 (c) 4 ms^{-1} (d) $8 \times 10^2 \text{ ms}^{-1}$

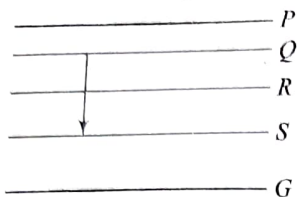
8. Energy levels A, B, C of a certain atom corresponding to increasing values of energy, i.e., $E_A < E_B < E_C$. If λ_1 , λ_2 and λ_3 are the wavelengths of radiations corresponding to the transitions C to B, B to A and C to A respectively, which of the following statements is correct



- (a) $\lambda_3 = \lambda_1 + \lambda_2$ (b) $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$
 (c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (d) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

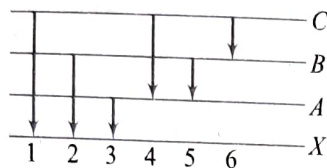
4.4 Optics and Modern Physics

9. Figure shows the energy levels P, Q, R, S and G of an atom where G is the ground state. A red line in the emission spectrum of the atom can be obtained by an energy level change from Q to S . A blue line can be obtained by the following energy level change



- (a) P to Q (b) Q to R (c) R to S (d) R to G

10. The figure indicates the energy level diagram of an atom and the origin of six spectral lines in emission (e.g. line no. 5 arises from the transition from level B to A). The following spectral lines will also occur in the absorption spectrum



- (a) 1, 4, 6 (b) 4, 5, 6
(c) 1, 2, 3 (d) 1, 2, 3, 4, 5, 6
11. A hydrogen like atom of atomic number Z is in an excited state of quantum number $2n$. It can emit a maximum energy photon of 204 eV. If it makes a transition to quantum state n , a photon of energy 40.8 eV is emitted. The value of n will be

- (a) 1 (b) 2 (c) 3 (d) 4

Matching Column Type

12. The energy, the magnitude of linear momentum, magnitude of angular momentum and orbital radius of an electron in a hydrogen atom corresponding to the quantum number n are E, p, L and r respectively. Then according to Bohr's theory of hydrogen atom, match the expressions in column I with statement in column II.

Column I		Column II	
(p)	Epr	(a)	is independent of n .
(q)	p/E	(b)	is directly proportional to n .
(r)	Er	(c)	is inversely proportional to n .
(s)	pr	(d)	is directly proportional to L .

Comprehension Type

A single electron orbits around a stationary nucleus of charge $+ze$, where z is a constant and e is the magnitude of electronic charge. It requires 47.2 eV to excite the electron from the second Bohr orbit to the third Bohr orbit.

13. The value of z
(a) 5 (b) 4 (c) 2 (d) 3
14. The energy required to excite the electron from the third to the fourth orbit
(a) 13.6 eV (b) 16.53 eV
(c) 47.2 eV (d) 27.2 eV
15. The potential energy of the electron in the first orbit is
(a) 340 eV (b) -340 eV
(c) 680 eV (d) -680 eV

Answers Key

Single Correct Answer Type

1. (c) 2. (a) 3. (c) 4. (a) 5. (b)
6. (b) 7. (c) 8. (b) 9. (d) 10. (c)
11. (b)

Matching Column Type

12. (p) $\rightarrow$ (c); (q) $\rightarrow$ (b, d); (c) $\rightarrow$ (r, a); (s) $\rightarrow$ (b, d)

Comprehension Type

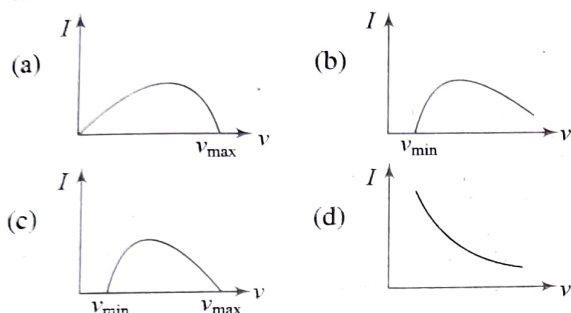
13. (a) 14. (b) 15. (a)

DPP 4.3

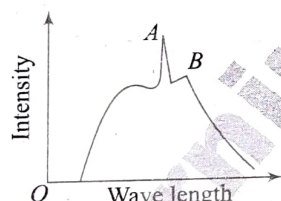
X-Rays

Single Correct Answer Type

1. The continuous x-ray spectrum obtained from a Coolidge tube is of the form



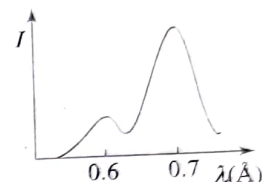
2. The figure represents the observed intensity of X-rays emitted by an X-ray tube as a function of wavelength. The sharp peaks A and B denote



- (a) band spectrum
(b) continuous spectrum
(c) characteristic radiations
(d) white radiations
3. If the potential difference between the anode and cathode of the X-ray tube increases
- (a) the peaks at R and S would move to shorter wavelength
(b) the peaks at R and S would remain at the same wavelength
(c) the cut-off wavelength at P would decrease
(d) (b) and (c) both are correct
4. If a voltage applied to an X-ray tube is increased to 1.5 times the minimum wavelength ($\lambda_{\min}$) of an X-ray continuous spectrum shifts by $\Delta\lambda = 26$ pm. The initial voltage applied to the tube is
- (a) ≈ 10 kV (b) ≈ 16 kV
(c) ≈ 50 kV (d) ≈ 75 kV
5. In X-ray tube when the accelerating voltage V is halved, the difference between the wavelength of K_{α} line and minimum wavelength of continuous X-ray spectrum
- (a) remains constant

- (b) becomes more than two times
(c) becomes half
(d) becomes less than two times

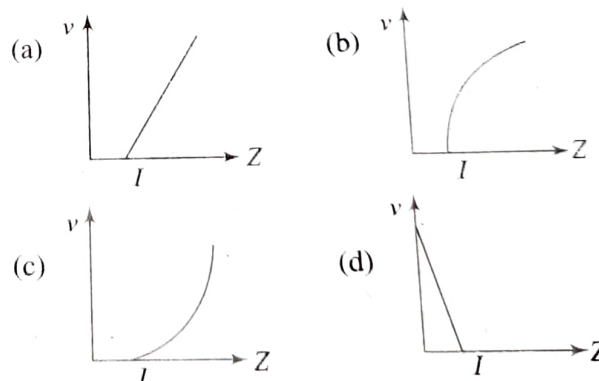
6. In the diagram a graph between the intensity of X-rays emitted by a molybdenum target and the wavelength is shown, when electrons of 30 keV are incident on the target. In the graph one peak is of K_{α} line and the other peak is of K_{β} line



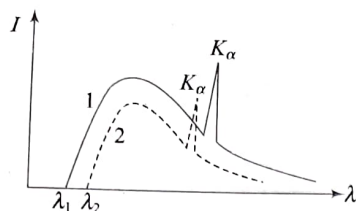
- (a) first peak is of K_{α} line at $0.6 \text{ \AA}$
(b) highest peak is of K_{α} line at $0.7 \text{ \AA}$
(c) if the energy of incident particles is increased, then the peaks will shift towards left
(d) if the energy of incident particles is increased, then the peaks will shift towards right
7. Let λ_{α} , λ_{β} and λ'_{α} denote the wavelengths of the X-rays of the K_{α} , K_{β} and L_{α} lines in the characteristic X-rays for a metal

- (a) $\lambda_{\alpha} > \lambda'_{\alpha} > \lambda_{\beta}$ (b) $\lambda'_{\alpha} > \lambda_{\beta} > \lambda_{\alpha}$
(c) $\frac{1}{\lambda_{\beta}} = \frac{1}{\lambda_{\alpha}} + \frac{1}{\lambda'_{\alpha}}$ (d) $\frac{1}{\lambda_{\alpha}} + \frac{1}{\lambda_{\beta}} = \frac{1}{\lambda'_{\alpha}}$

8. The graph that correctly represents the relation of frequency ν of a particular characteristic X-ray with the atomic number Z of the material is



9. The intensity distribution of X-rays from two Coolidge tubes operated on different voltages V_1 and V_2 and using different target materials of atomic numbers Z_1 and Z_2 is shown in the figure. Which one of the following inequalities is true?



- (a) $V_1 > V_2, Z_1 < Z_2$ (b) $V_1 > V_2, Z_1 > Z_2$
 (c) $V_1 < V_2, Z_1 > Z_2$ (d) $V_1 = V_2, Z_1 < Z_2$
10. The X-ray wavelength of L_α line of platinum ($Z = 78$) is $1.30 \text{ \AA}$. The X-ray wavelength of L_α line of molybdenum ($Z = 42$) is
 (a) $5.41 \text{ \AA}$ (b) $4.20 \text{ \AA}$ (c) $2.70 \text{ \AA}$ (d) $1.35 \text{ \AA}$
11. The K_α X-rays arising from a cobalt ($z = 27$) target have a wavelength of 179 pm . The K_α X-rays arising from a nickel target ($z = 28$) is
 (a) $>179 \text{ pm}$ (b) $<179 \text{ pm}$
 (c) $=179 \text{ pm}$ (d) None of these
12. For characteristic X-ray of some material
 (a) $E(K_\gamma) < E(K_\beta) < E(K_\alpha)$
 (b) $E(K_\alpha) < E(L_\alpha) < E(M_\alpha)$
 (c) $\lambda(K_\gamma) < E(K_\beta) < E(K_\alpha)$
 (d) $\lambda(M_\gamma) < \lambda(L_\beta) < \gamma(K_\alpha)$
13. The wavelength K_α X-rays produced by an X-ray tube is $0.76 \text{ \AA}$. The atomic number of anticathode material is
 (a) 82 (b) 41 (c) 20 (d) 10
14. The wavelength of K_α line for an element of atomic number 43 is λ . Then the wavelength of K_α line for an element of atomic number 29 is
 (a) $\frac{43}{29}\lambda$ (b) $\frac{42}{28}\lambda$ (c) $\frac{9}{4}\lambda$ (d) $\frac{4}{9}\lambda$
15. The potential difference applied to an X-ray tube is increased. As a result, in the emitted radiation
 (a) the intensity increases
 (b) the minimum wavelength increases
 (c) the intensity remains unchanged
 (d) the minimum wavelength decreases

Multiple Correct Answers Type

Answers Key

Single Correct Answer Type

1. (a) 2. (c) 3. (d) 4. (b) 5. (d)
 6. (b) 7. (c) 8. (c) 9. (a) 10. (a)
 11. (b) 12. (c) 13. (b) 14. (c)

Multiple Correct Answers Type

15. (a, d)

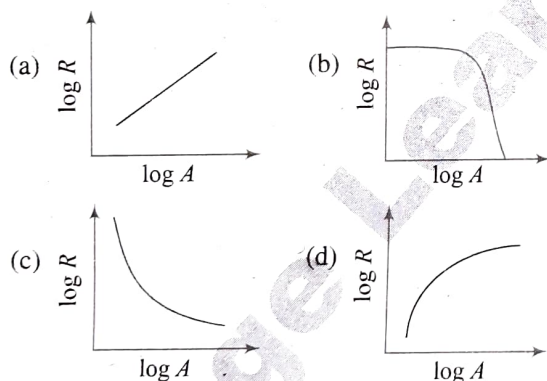
Nuclear Physics

DPP 5.1

Atomic Nucleus and Mass Defect

Single Correct Answer Type

1. The graph between $\log R$ and $\log A$ where R is the nuclear radius and A is the mass number is



2. The ratio of radii of nuclei ${}_{13}\text{Al}^{27}$ and ${}_{52}\text{X}^A$ is 3 : 5. The number of neutrons in the nuclei of X will be
(a) 52 (b) 73 (c) 125 (d) 13
3. Radius of ${}^4_2\text{He}$ nucleus is 3 Fermi. The radius of ${}^{206}_{82}\text{Pb}$ nucleus will be
(a) 5 Fermi (b) 6 Fermi
(c) 11.16 Fermi (d) 8 Fermi
4. What is the radius of iodine atom (at. no. 53, mass number 126)?
(a) 2.5×10^{-11} m (b) 2.5×10^{-9} m
(c) 7×10^{-9} m (d) 7×10^{-6} m

5. A heavy nucleus at rest breaks into two fragments which fly off with velocities in the ratio 8 : 1. The ratio of radii of the fragments is
(a) 1 : 2 (b) 1 : 4 (c) 4 : 1 (d) 2 : 1
6. Order of magnitude of density of uranium nucleus is ($m_p = 1.67 \times 10^{-27}$ kg)
(a) 10^{20} kg/m³ (b) 10^{17} kg/m³
(c) 10^{14} kg/m³ (d) 10^{11} kg/m³
7. α -particles of energy 400 KeV are bombarded on nucleus of ${}_{82}\text{Pb}$. In scattering of α -particles, its minimum distance from nucleus will be
(a) 0.59 nm (b) 0.59 Å (c) 5.9 pm (d) 0.59 pm
8. In nuclear reaction ${}_2\text{He}^4 + {}_Z\text{X}^A \rightarrow {}_{Z+2}\text{Y}^{A+3} + A$, A denotes
(a) electron (b) positron
(c) proton (d) neutron
9. For a nucleus to be stable, the correct relation between neutron number N and proton number Z is
(a) $N > Z$ (b) $N = Z$
(c) $N < Z$ (d) $N \geq Z$
10. Two nucleons are at a separation of 1×10^{-15} m. The net force between them is F_1 , if both are neutrons, F_2 if both are protons and F_3 if one is a proton and other is a neutron. In such a case
(a) $F_2 > F_1 > F_3$ (b) $F_1 = F_2 = F_3$
(c) $F_1 = F_2 > F_3$ (d) $F_1 = F_3 > F_2$
11. M_n and M_p represent mass of neutron and proton respectively. If an element having atomic mass M has N -neutron and Z -proton, then the correct relation will be

5.2 Optics and Modern Physics

- (a) $M < [NM_n + ZM_p]$
 (b) $M > [NM_n + ZM_p]$
 (c) $M = [NM_n + ZM_p]$
 (d) $M = N[M_n + M_p]$
12. If m , m_n and m_p are the masses of ${}_Z^AX^A$ nucleus, neutron and proton respectively
 (a) $m < (A - Z)m_n + Zm_p$
 (b) $m = (A - Z)m_n + Zm_p$
 (c) $m = (A - Z)m_p + Zm_n$
 (d) $m > (A - Z)m_n + Zm_p$
13. The rest energy of an electron is
 (a) 510 KeV (b) 931 KeV
 (c) 510 MeV (d) 931 MeV

Multiple Correct Answers Type

14. Let m_p be the mass of proton, m_n the mass of neutron, M_1 the mass of ${}^{20}_{10}\text{Ne}$ nucleus and M_2 the mass of ${}^{40}_{20}\text{Ca}$ nucleus. Then:
 (a) $M_2 = 2M_1$ (b) $M_2 > 2M_1$
 (c) $M_2 < 2M_1$ (d) $M_1 < 10(m_n + m_p)$
15. The mass number of a nucleus is:
 (a) always less than its atomic number
 (b) always greater than its atomic number
 (c) sometimes equal to its atomic number
 (d) sometimes more than and sometimes equal to its atomic number

Answers Key

Single Correct Answer Type

1. (a) 2. (b) 3. (c) 4. (a) 5. (a)
 6. (b) 7. (d) 8. (d) 9. (d) 10. (b)
 11. (a) 12. (a) 13. (a)

Multiple Correct Answers Type

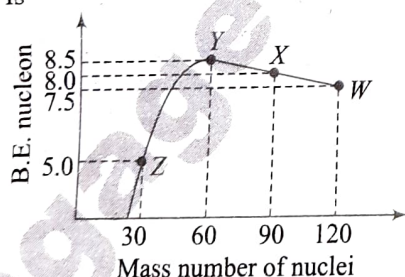
14. (c, d) 15. (c, d)

Cengage Learning India

DPP 5.2

Binding Energy

- The mass defect in a particular nuclear reaction is 0.3 grams. The amount of energy liberated in kilowatt hours is (Velocity of light = 3×10^8 m/s)
 - 1.5×10^6
 - 2.5×10^6
 - 3×10^6
 - 7.5×10^6
- If a proton and anti-proton come close to each other and annihilate, how much energy will be released
 - 1.5×10^{-10} J
 - 3×10^{-10} J
 - 4.5×10^{-10} J
 - None of these
- Binding energy of a nucleus is
 - energy given to its nucleus during its formation
 - total mass of nucleus converted to energy units
 - loss of energy from the nucleus during its formation
 - total K.E. and P.E. of the nucleons in the nucleus
- The binding energies per nucleon for a deuteron and an α -particle are x_1 and x_2 respectively. What will be the energy Q released in the reaction ${}_1\text{H}^2 + {}_1\text{H}^2 \rightarrow {}_2\text{He}^4 + Q$?
 - $4(x_1 + x_2)$
 - $4(x_2 - x_1)$
 - $2(x_1 + x_2)$
 - $2(x_2 - x_1)$
- The curve of binding energy per nucleon as a function of atomic mass number has a sharp peak for helium nucleus. This implies that helium
 - can easily be broken up
 - is very stable
 - can be used as fissionable material
 - is radioactive
- Binding energy per nucleon versus mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is
 - $Y \rightarrow 2Z$
 - $W \rightarrow X + Z$
 - $W \rightarrow 2Y$
 - $X \rightarrow Y + Z$
- The binding energy per nucleon is maximum in the case of
 - ${}_2^4\text{He}$
 - ${}_{26}^{56}\text{Fe}$
 - ${}_{56}^{141}\text{Ba}$
 - ${}_{92}^{235}\text{U}$
- The masses of neutron and proton are 1.0087 a.m.u. and 1.0073 a.m.u. respectively. If the neutrons and protons combine to form a helium nucleus (alpha particles) of mass 4.0015 a.m.u. The binding energy of the helium nucleus will be (1 a.m.u. = 931 MeV)
 - 28.4 MeV
 - 20.8 MeV
 - 27.3 MeV
 - 14.2 MeV
- The mass defect for the nucleus of helium is 0.0303 a.m.u. What is the binding energy per nucleon for helium in MeV?
 - 28
 - 7
 - 4
 - 1
- M_p denotes the mass of a proton and M_n that of a neutron. A given nucleus, of binding energy B , contains Z protons and N neutrons. The mass $M(N, Z)$ of the nucleus is given by (c is the velocity of light)
 - $M(N, Z) = NM_n + ZM_p - B/c^2$
 - $M(N, Z) = NM_n + ZM_p + B/c^2$
 - $M(N, Z) = NM_n + ZM_p - B/c^2$
 - $M(N, Z) = NM_n + ZM_p + B/c^2$
- The binding energy of deuteron ${}_1^2\text{H}$ is 1.112 MeV per nucleon and an α -particle ${}_2^4\text{He}$ has a binding energy of 7.047 MeV per nucleon. Then in the fusion reaction ${}_1^2\text{H} + {}_1^2\text{H} \rightarrow {}_2^4\text{He} + Q$, the energy Q released is
 - 1 MeV
 - 11.9 MeV
 - 23.8 MeV
 - 931 MeV
- If the binding energy per nucleon in Li^7 and He^4 nuclei are respectively 5.60 MeV and 7.06 MeV, then energy of reaction $\text{Li}^7 + p \rightarrow 2 {}_2^4\text{He}$ is
 - 19.6 MeV
 - 2.4 MeV
 - 8.4 MeV
 - 17.3 MeV
- The binding energy per nucleon of deuterium and helium atom is 1.1 MeV and 7.0 MeV. If two deuterium nuclei fuse to form helium atom, the energy released is
 - 19.2 MeV
 - 23.6 MeV
 - 26.9 MeV
 - 13.9 MeV
- A nucleus of ${}_{82}^{210}\text{Po}$ originally at rest emits α -particle with speed v . What will be the recoil speed of the daughter nucleus?
 - $4v/206$
 - $4v/214$
 - $v/206$
 - $v/214$
- The binding energy per nucleon of O^{16} is 7.97 MeV and that of O^{17} is 7.75 MeV. The energy (in MeV) required to remove a neutron from O^{17} is
 - 3.52
 - 3.64
 - 4.23
 - 7.86



Answers Key

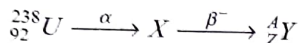
Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (b) | 5. (b) | 6. (c) | 7. (b) | 8. (a) | 9. (b) | 10. (c) |
| | | | | | 11. (c) | 12. (d) | 13. (b) | 14. (a) | 15. (c) |

DPP 5.3

 α , β and γ Decay and Radioactivity

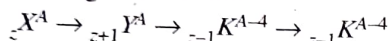
1. In the disintegration series



The value of Z and A respectively will be

- (a) 92, 236 (b) 88, 230 (c) 90, 234 (d) 91, 234

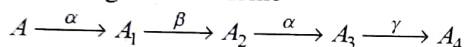
2. In the given reaction



Radioactive radiations are emitted in the sequence

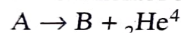
- (a)
- α, β, γ
- (b)
- β, α, γ
- (c)
- γ, α, β
- (d)
- β, γ, α

3. A radioactive nucleus undergoes a series of decay according to the scheme

If the mass number and atomic number of A are 180 and 72 respectively, then what are these numbers for A_4

- (a) 172 and 69 (b) 174 and 70
-
- (c) 176 and 69 (d) 176 and 70

4. An element A decays into element C by a two-step process:



Then

- (a) A and C are isotopes (b) A and C are isobars
-
- (c) A and B are isotopes (d) A and B are isobars

5. Half-lives of two radioactive substances A and B are respectively 20 minutes and 40 minutes. Initially the samples of A and B have equal number of nuclei. After 80 minutes, the ratio of the remaining number of A and B nuclei is
-
- (a) 1 : 16 (b) 4 : 1 (c) 1 : 4 (d) 1 : 1

6. The half-life of
- ${}^{131}\text{I}$
- is 8 days. Given a sample of
- ${}^{131}\text{I}$
- at time
- $t = 0$
- , we can assert that

- (a) No nucleus will decay before
- $t = 4$
- days
-
- (b) No nucleus will decay before
- $t = 8$
- days
-
- (c) All nuclei will decay before
- $t = 16$
- days
-
- (d) A given nucleus may decay at any time after
- $t = 0$

7. At any instant the ratio of the amount of radioactive substances is 2 : 1. If their half-lives be respectively 12 and 16 hours, then after two days, what will be the ratio of the substances?

- (a) 1 : 1 (b) 2 : 1 (c) 1 : 2 (d) 1 : 4

8. During mean life of a radioactive element, the fraction that disintegrates is

- (a)
- e
- (b)
- $\frac{1}{e}$
- (c)
- $\frac{e-1}{e}$
- (d)
- $\frac{e}{e-1}$

9. The activity of a sample of a radioactive material is A, at time
- t_1
- and
- A_2
- at time
- t_2
- (
- $t_2 > t_1$
-). If its mean life T, then

- (a)
- $A_1 t_1 = A_2 t_2$
- (d)
- $A_1 - A_2 = t_2 - t_1$
-
- (c)
- $A_2 = A_1 e^{(t_1 - t_2)/T}$
- (d)
- $A_2 = A_1 e^{(t_1/t_2)/T}$

10. The half-life of a sample of a radioactive substance is 1 hour. If
- 8×10^{10}
- atoms are present at
- $t = 0$
- , then the number of atoms decayed in the duration
- $t = 2$
- hour to
- $t = 4$
- hour will be

- (a)
- 2×10^{10}
- (b)
- 1.5×10^{10}
- (c) Zero (d) Infinity

11. Atomic mass number of an element thorium is 232 and its atomic number is 90. The end product of this radioactive element is an isotope of lead (atomic mass 208 and atomic number 82). The number of alpha and beta particles emitted is

- (a)
- $\alpha = 3, \beta = 3$
- (b)
- $\alpha = 6, \beta = 4$
-
- (c)
- $\alpha = 6, \beta = 0$
- (d)
- $\alpha = 4, \beta = 6$

12. A sample contains 16 gm of a radioactive material, the half life of which is two days. After 32 days, the amount of radioactive material left in the sample is

- (a)
- < 1
- mg (b)
- $\frac{1}{4}$
- gm
-
- (c)
- $\frac{1}{2}$
- gm (d) 1 gm

13. A radioisotope has a half-life of 5 years. The fraction of the atoms of this material that would decay in 15 years will be
-
- (a) 1/8 (b) 2/3 (c) 7/8 (d) 5/8

14. Three
- α
- particles and one
- β
- particle decaying takes place in series from an isotope
- ${}_{88}^{238}\text{Ra}$
- . Finally the isotope obtained will be

- (a)
- ${}_{84}^{220}\text{X}$
- (b)
- ${}_{86}^{222}\text{X}$
- (c)
- ${}_{83}^{224}\text{X}$
- (d)
- ${}_{83}^{215}\text{X}$

15. Radon (Ra) decays into polonium (
- Po
-) by emitting an
- α
- particle with half-life of 4 days. A sample contains
- 6.4×10^{10}
- atoms of Rn. After 12 days, the number of atoms of
- Po
- left in the sample will be

- (a)
- 3.2×10^{10}
- (b)
- 0.53×10^{10}
-
- (c)
- 2.1×10^{10}
- (d)
- 0.8×10^{10}

Answers Key

Single Correct Answer Type

11. (b) 12. (a) 13. (c) 14. (c) 15. (d)

1. (d) 2. (b) 3. (a) 4. (a) 5. (c)
-
6. (d) 7. (a) 8. (c) 9. (c) 10. (b)

DPP 5.4

Radioactivity

- If 10% of a radioactive material decays in 5 days, then the amount of original material left after 20 days is approximately
(a) 60% (b) 65% (c) 70% (d) 75%
- A radioactive isotope X with a half-life of 1.37×10^9 years decays to Y which is stable. A sample of rock from the moon was found to contain both the elements X and Y which were in the ratio of 1 : 7. The age of the rock is
(a) 1.96×10^8 years (b) 3.85×10^9 years
(c) 4.11×10^9 years (d) 9.59×10^9 years
- The half-life of radium is 1620 years and its atomic weight is 226 kgm per kilomol. The number of atoms that will decay from its 1 gm sample per second will be
(a) 3.61×10^{10} (b) 3.6×10^{12}
(c) 3.11×10^{15} (d) 31.1×10^{15}
- A radioactive material decays by simultaneous emission of two particles with respective half-lives 1620 and 810 years. The time (in years) after which one-fourth of the material remains is
(a) 1080 (b) 2430 (c) 3240 (d) 4860
- For a substance the average life for α -emission is 1620 years and for β emission is 405 years. After how much time the 1/4 of the material remains after α - and β -emission
(a) 1500 years (b) 300 years
(c) 449 years (d) 810 years
- A radioactive nucleus undergoes α -emission to form a stable element. What will be the recoil velocity of the daughter nucleus if V is the velocity of α -emission and A is the atomic mass of radioactive nucleus?
(a) $\frac{4V}{A-4}$ (b) $\frac{2V}{A-4}$ (c) $\frac{4V}{A+4}$ (d) $\frac{2V}{A+4}$
- Half-life of a radioactive substance is 20 minutes. Difference between points of time when it is 33% disintegrated and 67% disintegrated is approximately
(a) 10 min (b) 20 min
(c) 30 min (d) 40 min
- A and B are two radioactive substances whose half-lives are 1 and 2 years respectively. Initially 10 gm of A and 1 gm of B is taken. The time (approximate) after which they will have the same quantity remaining is
(a) 6.62 years (b) 5 years
(c) 3.2 years (d) 7 years
- Half-life of a radioactive substance is 20 minutes. The time between 20% and 80% decay will be
(a) 20 minutes (b) 40 minutes
(c) 30 minutes (d) 25 minutes
- Excitation energy of a hydrogen like ion in its first excitation state is 40.8 eV. Energy needed to remove the electron from the ion in ground state is
(a) 54.4 eV (b) 13.6 eV (c) 40.8 eV (d) 27.2 eV
- The rate of disintegration was observed to be 10^{17} disintegrations per sec when its half-life period is 1445 years. The original number of particles is
(a) 8.9×10^{27} (b) 6.6×10^{27}
(c) 1.4×10^{16} (d) 1.2×10^{17}
- A small quantity of solution containing Na^{24} radionuclide of activity 1 microcurie is injected into the blood of a person. A sample of the blood of volume 1 cm^3 taken after 5 hours shows an activity of 296 disintegration per minute. What will be the total volume of the blood in the body of the person? Assume that the radioactive solution mixes uniformly in the blood of the person.
(Take 1 curie = 3.7×10^{10} disintegration per second and $e^{-\lambda t} = 0.7927$, where λ = disintegration constant)
(a) 5.94 L (b) 2 L
(c) 317 L (d) 1 L
- A radioactive sample of U^{238} decay to Pb through a process for which half-life is 4.5×10^9 years. The ratio of number of nuclei of Pb to U^{238} after a time of 1.5×10^9 years (given $2^{1/3} = 1.26$)
(a) 0.12 (b) 0.26 (c) 1.2 (d) 0.37
- A radioactive sample is α -emitter with half-life 138.6 days is observed by a student to have 2000 disintegration/sec. The number of radioactive nuclei for given activity is
(a) 3.45×10^{10} (b) 1×10^{10}
(c) 3.45×10^{15} (d) 2.75×10^{11}
- If one starts with 1 curie of radioactive substance ($T_{1/2} = 12$ hrs) the activity left after a period of 1 week will be about
(a) 1 curie (b) 120 microcurie
(c) 60 microcurie (d) 8 millicurie

Answers Key

Single Correct Answer Type

- | | | | | | | | | | |
|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|
| 1. (b) | 2. (c) | 3. (a) | 4. (a) | 5. (c) | 6. (a) | 7. (b) | 8. (a) | 9. (b) | 10. (a) |
| | | | | | 11. (b) | 12. (a) | 13. (b) | 14. (a) | 15. (c) |

DPP 5.5

Nuclear Fission and Fusion

- Atomic power station at Tarapore has a generating capacity of 200 MW. The energy generated in a day by this station is
(a) 200 MW (b) 200 J
(c) 4800×10^6 J (d) 1728×10^6 J
- 200 MeV of energy may be obtained per fission of ^{235}U . A reactor is generating 1000 kW of power. The rate of nuclear fission in the reactor is
(a) 1000 (b) 2×10^8
(c) 3.125×10^{16} (d) 931
- If 200 MeV energy is released in the fission of a single ^{235}U nucleus, the number of fissions required per second to produce 1 kilowatt power shall be (Given $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$)
(a) 3.125×10^{13} (b) 3.125×10^{14}
(c) 3.125×10^{15} (d) 3.125×10^{16}
- Energy released in the fission of a single ^{235}U nucleus is 200 MeV. The fission rate of a ^{235}U fuelled reactor operating at a power level of 5 W is
(a) $1.56 \times 10^{+10} \text{ s}^{-1}$ (b) $1.56 \times 10^{+11} \text{ s}^{-1}$
(c) $1.56 \times 10^{+16} \text{ s}^{-1}$ (d) $1.56 \times 10^{+17} \text{ s}^{-1}$
- If a proton and antiproton come close to each other and annihilate, how much energy will be released
(a) $1.5 \times 10^{-10} \text{ J}$ (b) $3 \times 10^{-10} \text{ J}$
(c) $4.5 \times 10^{-10} \text{ J}$ (d) None of these
- Energy released in fusion of 1 kg of deuterium nuclei
(a) $8 \times 10^{13} \text{ J}$ (b) $6 \times 10^{27} \text{ J}$
(c) $2 \times 10^7 \text{ kWh}$ (d) $8 \times 10^{23} \text{ MeV}$
- If the energy released in the fission of one nucleus is 200 MeV. Then the number of nuclei required per second in a power plant of 16 kW will be
(a) 0.5×10^{14} (b) 0.5×10^{12}
(c) 5×10^{12} (d) 5×10^{14}
- To generate a power of 3.2 megawatt, the number of fissions of ^{235}U per minute is
(Energy released per fission = 200 MeV, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$)
(a) 6×10^{18} (b) 6×10^{17} (c) 10^{17} (d) 6×10^{16}
- The binding energy per nucleon of deuterium and helium atom is 1.1 MeV and 7.0 MeV. If two deuterium nuclei fuse to form helium atom, the energy released is
(a) 19.2 MeV (b) 23.6 MeV
(c) 26.9 MeV (d) 13.9 MeV
- The energy liberated on complete fission of 1 kg of ^{235}U is (Assume 200 MeV energy is liberated on fission of 1 nucleus)
(a) $8.2 \times 10^{10} \text{ J}$ (b) $8.2 \times 10^9 \text{ J}$
(c) $8.2 \times 10^{13} \text{ J}$ (d) $8.2 \times 10^{16} \text{ J}$
- The nuclear reaction $^2\text{H} + ^2\text{H} \rightarrow ^4\text{He}$ (mass of deuteron = 2.0141 a.m.u. and mass of He = 4.0024 a.m.u.) is
(a) fusion reaction releasing 24 MeV energy
(b) fusion reaction absorbing 24 MeV energy
(c) fission reaction releasing 0.0258 MeV energy
(d) fission reaction absorbing 0.0258 MeV energy
- Fission of nuclei is possible because the binding energy per nucleon in them
(a) increases with mass number at high mass numbers
(b) decreases with mass number at high mass numbers
(c) increases with mass number at low mass numbers
(d) decreases with mass number at low mass numbers
- An atomic power nuclear reactor can deliver 300 MW. The energy released due to fission of each nucleus of uranium atom ^{238}U is 170 MeV. The number of uranium atoms fissioned per hour will be
(a) 30×10^{25} (b) 4×10^{22}
(c) 10×10^{20} (d) 5×10^{15}

Multiple Correct Answers Type

- Which of the following statement(s) is/are correct (may have more than one option correct):
(a) the rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleons.
(b) the rest mass of a stable nucleus is greater than the sum of the rest masses of its separated nucleons.
(c) in nuclear fission, energy is released by fusing two nuclei of medium mass (approximately 100 amu).
(d) in nuclear fission, energy is released by fragmentation of a very heavy nucleus.

Matching Column Type

- Match the statements of column I and column II

	Column I		Column II
(A)	Mass number is conserved in	(P)	Nuclear fission
(B)	Binding energy per nucleon increases in	(Q)	Nuclear fusion
(C)	Charge conservation is possible in	(R)	Alpha decay
(D)	Original mass of the system is greater than mass of the products formed in	(S)	Beta decay

Answers Key

Single Correct Answer Type

- | | | | | |
|---------|---------|---------|--------|---------|
| 1. (d) | 2. (c) | 3. (a) | 4. (b) | 5. (b) |
| 6. (a) | 7. (d) | 8. (a) | 9. (b) | 10. (c) |
| 11. (a) | 12. (b) | 13. (b) | | |

Matching Column Type

15. (A) $\rightarrow$ (P, Q, R, S); (B) $\rightarrow$ (P, Q, R, S);
(C) $\rightarrow$ (P, Q, R, S); (D) $\rightarrow$ (P, Q, R, S)

Multiple Correct Answers Type

14. (a, d)

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